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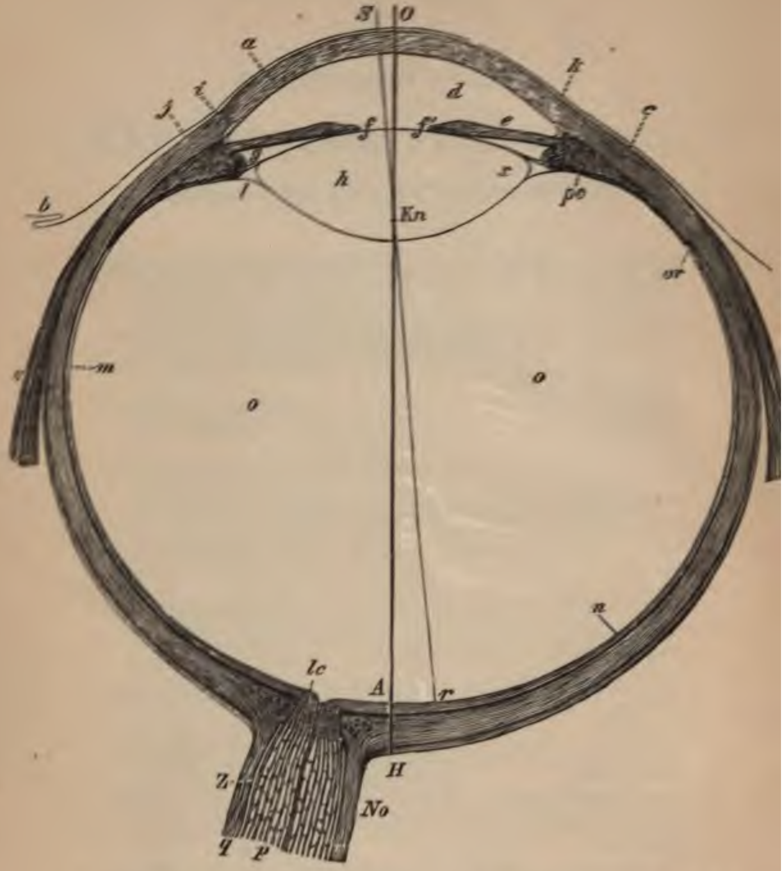

FIG. I. HORIZONTAL SECTION OF THE RIGHT EYE. (*Landois.*)

a, Cornea; *b*, conjunctiva; *c*, sclerotic; *d*, anterior chamber containing the aqueous humor; *e*, i
ff', pupil; *g*, posterior chamber; *l*, Petit's canal; *j*, ciliary muscle; *k*, corneo-scleral limit; *i*, ca
of Schlemm; *m*, choroid; *n*, retina; *o*, vitreous humor; *No*, optic nerve; *q*, nerve-sheat
p, nerve-fibres; *lc*, lamina cribrosa. The line, *O A*, indicates the optic axis; *S r*, the axis of visi
r, the position of the fovea centralis.

? QUIZ-COMPENDS ? No. 8.

A

COMPEND

OF THE

DISEASES OF THE EYE;

INCLUDING

REFRACTION AND SURGICAL OPERATIONS.

BY

L. WEBSTER FOX, M.D.,

OPHTHALMIC SURGEON TO THE GERMANTOWN HOSPITAL; CLINICAL ASSISTANT OPHTHALMOLOGICAL DEPARTMENT, JEFFERSON MEDICAL COLLEGE HOSPITAL; LATE CLINICAL ASSISTANT, MOORFIELDS, LONDON, ETC., ETC.

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TO

THEIR FRIENDS AND FELLOW-STUDENTS,

THE

UNDERGRADUATES AND ALUMNI

OF

JEFFERSON MEDICAL COLLEGE,

WITH SO MANY OF WHOM THE AUTHORS HAVE BEEN PLEASANTLY
AND FRATERNALLY ASSOCIATED.

88321

PREFACE.

It is needless to say the present little work aims at no exhaustive treatment of any branch of the subject, and is not designed for specialists. It has in view two definite and modest purposes: First, to supply the medical undergraduate with the most notable points concerning the diagnosis and treatment of ocular disorders, whether pathological or refractive. Many an earnest student has felt the desire to see around and over the subject—*sich orientiren*, as the Germans happily phrase it—but has been appalled at the task when he saw the books required to give him this over-look. Heretofore, no single concise account has been offered him within the covers of a small volume, of the leading facts relating to the refraction, diseases and surgery of the eye.

Our second object has been to give the busy general practitioner, who has never considered the importance of this knowledge to himself, or has relied upon his neighbor, the oculist, to do all such work for his patients, a few outlines of the science. Were he, even to a limited extent, master of such outlines, his patients would often be spared much suffering and himself much chagrin.

In the endeavor and necessity to compass a *résumé* of the subject within certain limits, logical sequence and connections have often had to be sacrificed, results stated with no showing of reasons and preliminary steps; authorities left out, and omissions made, without excuse. Among the latter that are most noticable, the whole question of Pathological Anatomy may be remarked. But those who may feel like criticising such neglect, will not be they who regret it, since any who might make use of such knowledge would have already gone far beyond our insignificant ten-line condensations.

L. WEBSTER FOX,
GEORGE M. GOULD.

Philadelphia, October 30th, 1886.

CONTENTS.

PART I.

REFRACTION OF THE EYE. PAGE

Résumé of Optical Principles 9
Accommodation 16
Emmetropia and Ametropia 18
Refraction of the Eye 20
The Ophthalmoscope 22
Test Letters and Lenses 26
Mydriaties 27
Retinoscopy 29
Hyperopia 32
Myopia 35
Astigmatism 38
Prescribing Spectacles 46
Anisometropia 49
Presbyopia 50

PART II.

FUNCTIONAL DISORDERS AFFECTING VISION.

Paralyses 53
Spasms 56
Muscular Incoördination—Strabismus 57
Asthenopia 60
Amblyopia 60
Diminution of the Field of Vision 63
Color-Blindness 64
Hyperesthesia of the Retina 66

PART III.

DISEASES OF THE EYE.

Diseases of the Lids.

Blepharitis 67
Hordeolum 67
Chalazion 68
Entropion 68
Ectropion

Diseases of the Lachrymal Apparatus. PAGE

Dacryo-Adenitis.......... 69
Epiphora.......... 69
Dacryo-Cystitis.......... 70

Diseases of the Conjunctiva.

Palpebral Conjunctivitis.......... 71
Muco-Purulent Conjunctivitis.......... 71
Purulent Conjunctivitis.......... 72
Trachoma.......... 75
Phlyctenular Conjunctivitis.......... 76
Pterygium.......... 77

Diseases of the Cornea.

Phlyctenular Keratitis.......... 77
Interstitial Keratitis.......... 78
Suppurative Keratitis.......... 79

Diseases of the Sclerotic.

Episcleritis and Scleritis.......... 81

Diseases of the Iris and Ciliary Body.

Iritis.......... 82
Cyclitis.......... 83

Diseases of the Choroid.

Choroiditis.......... 84

Diseases of the Crystalline Lens.

Cataract.......... 87

Diseases of the Vitreous.

Hyalitis.......... 91

Diseases of the Retina.

General considerations.......... 92
Retinitis.......... 94
Detachment of the Retina.......... 99
Glioma of the Retina.......... 99

Diseases of the Optic Nerve.

Papillitis.......... 100
Atrophy of the Optic Nerve.......... 103

General Diseases.

Glaucoma.......... 104
Sympathetic Ophthalmitis.......... 107
Exophthalmic Goitre.......... 109

PART IV.

SURGICAL OPERATIONS, ETC. INSTRUMENTS. PAGE

Distichiasis, Trichiasis and Entropion........ 110
Ectropion........ 112
Closure of the Lachrymal Duct, etc........ 115
Peritomy; Tenotomy........ 117
Advancement; Paracentesis, Staphyloma of Cornea........ 118
Conical Cornea, Iridectomy........ 119
Sclerotomy, Discission........ 120
Cataract........ 121
Enucleation........ 126
Wounds and Injuries........ 127
Surgical Instruments........ 130
Statistical........ 136
Formulæ........ 140
Clinical Hints........ 145
Index........ 147

NTRACTIONS, ETC., USED IN THIS COMPEND

Acc.	Accommodation, Accommodative Power.
As.	Astigmatism, Astigmatic.
C.	Centigrade.
Cm.	Centimetre.
Cyl.	Cylinder, Cylindrical Lens.
D.	Dioptrie, Dioptric.
E.	Emmetropia, Emmetropic.
F.	Formula—List on page 139.
H.	Hyperopia, Hypermetropia, Hyperopic.
L.	Left.
M.	Myopia, Myopic.
mm.	Millimetre.
O. D.	Right Eye.
O. S.	Left Eye.
p. p.	Punctum Proximum, Near Point.
p. r.	Punctum Remotum, Far Point.
R.	Right.
Sph.	Spherical, Spherical Lens.
V.	Vision, Acuteness of vision.
+, −, =	Plus, minus, equal to.
∞	Infinity, practically considered as 20 feet away.
$\overset{\frown}{\smile}$	Combined with.

A COMPEND

OF

THE DISEASES AND REFRACTION

OF

THE EYE.

PART I.

REFRACTION OF THE EYE.

Anatomy of the Eye.—It is, of course, unnecessary to say that all proper treatment of the refractive errors, or of the diseases, of the eye, presupposes and demands a knowledge of its anatomy. Want of space compels us to omit a preliminary sketch of these details, and this is the less reprehensible because such an abstract already exists in the **Quiz-Compend on Anatomy** issued by the same publishers as is this volume; the student is therefore referred to that for a statement of the main facts of the anatomy of the orbital bones, the ocular muscles, and the structures of the globe itself.

Résumé of Optical Principles.—Light and color, properly speaking, do not exist outside of the mind; they are sensations, creations by the brain upon its receipt of optic nerve messages from the retina. It is also more than probable that the neural vibration itself is not directly connected with the purely physical stimulus, but is the result of a molecular activity aroused by that stimulus in an intermediate receptive substance. We thus see that there are several transmutations of force between the external visible object and the phenomenon of consciousness we call light, but to avoid circumlocution we all speak of the physical cause of light as light itself, though scientifically speaking we are well aware of the absurdity.

The molecules or atoms of a body, so long as that body is of a temperature below 525° C., have only that amplitude and rapidity of vibration which induce in the ether pressing about them the ethereal wave-motion we call radiant heat; that is, the ethereal oscillations are of a lesser frequency than 392 millions of millions per second. So soon as the temperature of a body rises above 525° C., it becomes (in the dark) visible, or self-luminous; its wave frequency rises above that of the numbers given, and we have the sensation red when looking upon it. With every increase of heat the vibrations of its molecules increase their rates of movement till the resultant ethereal movements reach a rapidity of arrival at the retina expressed by the figures 757,000,000,000,000. Above these frequencies we know the ether vibrates in higher and higher numbers, but these quicker movements produce no effect on the eye. The mind interprets as color the different rates of frequency between the two before-mentioned limits, and the combined effect of all frequencies (in the proportions furnished by sunlight) produces the sensation of dazzling white. **Common sunlight,** therefore, contains a mixture of all wave-lengths and frequencies, including the *dark or Invisible Heat Rays*, the *Light Rays*, and the *Ultra-violet or Actinic Rays*, as the upper invisible portion is called. Wave-length, wave-frequency and wave-refrangibility (the bending they undergo in passing into a denser medium) are all proportional to one another. The greater the wave-length the less both its frequency and its refrangibility. A prism, or a diffraction grating, ranges the homogeneous rays, massed together in a compound ray of sunlight, in a band, according to their refrangibility; this band, or ribbon of colors, is called **the spectrum.** By accurately delimiting the colors produced we find that daylight is made up of the following proportions of elemental colors: Red, 54 parts; orange-red, 140; orange, 80; orange-yellow, 114; yellow, 54; greenish-yellow, 206; yellowish-green, 121; green, and blue-green, 134; cyan-blue, 32; blue, 40; ultramarine, and blue-violet, 20; violet, 5; total, 1000.

Again, all objects below a temperature of 525° C. become visible only by reflected light, and the colors of these objects are such as they are, because the light of day is partially absorbed by them, and partially reflected. If a body absorbs the rays of that frequency producing a certain color, it is of course, not of that color, but appears of that tint which is produced by the mixture of the reflected waves. **The Fraunhofer lines** of the spectrum are dark striæ caused by the arrestation of rays of certain frequencies by molecules in the sun's atmosphere, having the same vibrational periods.

The following table gives the wave frequencies and corresponding lengths of the chief Fraunhofer lines and colors of the visible spectrum:

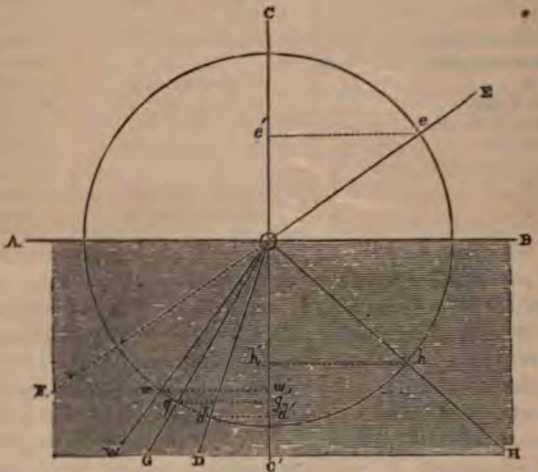
	Frequencies—per sec.	*Lengths in Cm.*
Line A	395,000,000,000,000	.00007604
Centre of red	. . . . . .	.00007000
Line B	437,300,000,000,000	.00006867
Line C	457,700,000,000,000	.00006562
Centre of orange-red	. . . . . .	.00006208
Centre of orange	. . . . . .	.00005972
Line D^1	508,905,810,000,000	.00005895
Line D^2	510,604,000,000,000	.00005889
Centre of orange-yellow	. . . . . .	.00005879
Centre of yellow	. . . . . .	.00005808
Centre of green	. . . . . .	.00005271
Line E	570,000,000,000,000	.00005269
Line b^*	. . . . . .	.00005183
Centre of blue-green	. . . . . .	.00005082
Centre of cyan-blue	. . . . . .	.00004960
Line F	617,900,000,000,000	.00004861
Centre of blue	. . . . . .	.00004732
Centre of violet-blue	. . . . . .	.00004383
Line G	697,300,000,000,000	.00004307
Centre of puce-violet	. . . . . .	.00004059
Line H^1	756,900,000,000,000	.00003968
Line H^2	763,600,000,000,000	.00003933

These and all other wave frequencies pass through space at a common speed, 186,680 miles per second. So long as light traverses a homogeneous medium it proceeds in straight lines, but upon striking a (transparent) medium of greater density—as for instance, in passing from air into water—it is deflected from its preceding course, as is shown in the accompanying figure 2, when the incident ray E O, instead of proceeding to F is bent out of its course and takes the direction O W. Were the refracting medium glass, the refraction of E O would be greater, represented by the course of the line O G; were the medium diamond, for example, O D would be the direction of the bended ray. *The angle of incidence* is E O C, *the angles of refraction*, W O C, G O C, D O C. The sine of the angle of incidence *e e′*, bears a constant ratio to the sines of the angles of refraction *w w′*, *g g′*, *d d′*, and this ratio is called **the Index of Refraction.** For water, this index is 1.336, *i.e.*, the sine *e e′* is to the sine *w w′*, as 1.336 is to 1, or about 1⅓ to 1, or 4 to 3. The Index of Refraction of flint glass is about 1.6, or 8 to 5, of diamond, 5 to 1.

It will be noticed the direction of the refracted ray always inclines toward the perpendicular, C C′, and this fact gives us the second of the two chief data we must have in order to understand what takes place when a beam of light strikes a test lens, a spectacle glass, or the refractive media of the eye. *The beam is refracted toward the perpendicular* to the plane dividing the two different media, according to the angle of incidence and the refractive index of the denser media. Upon emergence from the denser into the rarer medium again, the ray once more takes up the original direction, or pursues a line parallel, not identical, with its former course.

In passing through a prism of glass, we now see why the spectrum is formed: all the waves are bent toward the perpendicular, but in different degrees according to the varying wave length (or kinetic energy) of the component parts of the incident beam. This is illustrated by the annexed Fig. 3.

FIG. 2.



The Lenses used in the correction of ocular refractive errors are divisible into two classes:—

1. Those with thin edges and thicker centres, which converge the rays, called convex lenses;

2. Those with thick edges and thinner centres, which scatter the rays,—concave lenses.

Illustrations of these are given in Fig. 4.

The first class, Nos. 1, 2, 3, are naturally called positive; the second, Nos. 4, 5, 6, negative. No. 1 is commonly spoken of as a plus spherical; No. 2, a plus cylinder; No. 4, a minus spherical; and No. 5, a minus cylinder. Nos. 3 and 6 are not used in ophthalmic practice. Examination of these lenses in a test case shows at once the reason of the names, spherical and cylinder, since the glasses may be supposed segments of such forms.

FIG. 3.

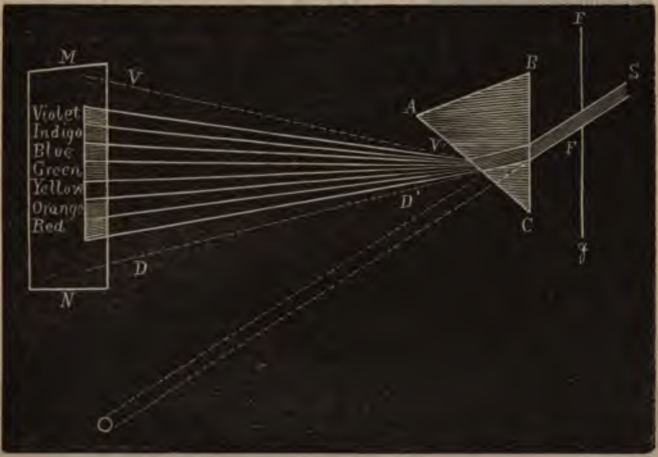
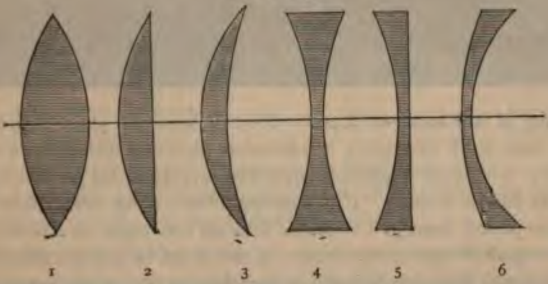
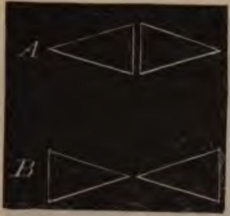


FIG. 4.



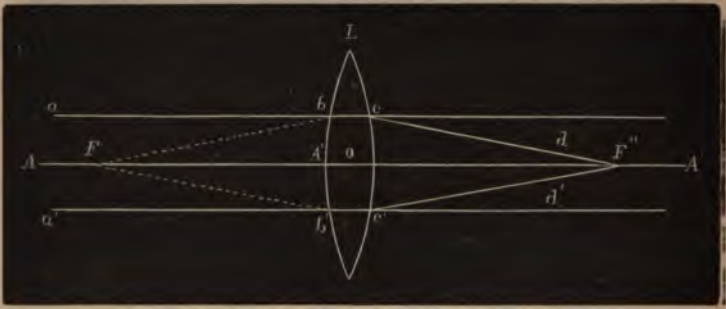
The best way to represent the action of these lenses upon light is to consider them as formed of a set of double prisms, placed base to base in the convergent lenses, and apex to apex in the divergent ones. By applying the laws of the refraction of light already mentioned to these forms, we at once perceive the rationale of their action. It is evident from Figure 5 that the incident rays will be brought to a focus more speedily after emerging from the positive spherical lens, if the lens be thickened at the centre, or if the juxtaposed bases of the prisms be broadened. The converse, of course, holds true of the scattering power of the negative spherical lenses.

FIG. 5.



Cylindrical glasses follow the same law as spherical ones, but since they have no curve parallel to their axes they cannot form images, only foci of incident rays at right angles to the axis.

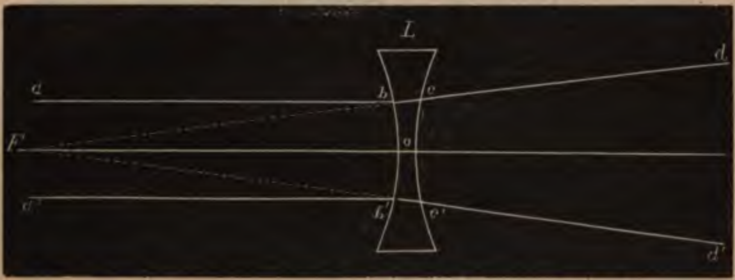
FIG. 6.



Action of a Biconvex Lens.—From a luminous point or body rays of light issue in all directions; it is therefore plain that such rays are always divergent. For practical purposes, however, rays are called parallel, coming from "an infinite distance," if proceeding from a point twenty feet away. Such rays passed through a biconvex lens are converged to a point called the **Principal Focus** of that lens. If the object be a point situated at a distance nearer than twenty feet, it is clear that the rays will be more plainly divergent and will be brought to a focus at a point further from the lens than the principal focus, while convergent rays will be focalized within the principal focus. It follows as a corollary that rays from the principal focus are rendered parallel by their passage through the lens, and rays from within the distance of the principal focus emerge still divergent, while rays from beyond the principal focus are rendered convergent. These definitions are illustrated by Fig. 6. The axis ray, A A′, is unrefracted, while parallel rays, *a a′*, are brought to the principal focus, F′. Conversely, rays from F′ are rendered parallel. Were *a a′* convergent, their focus would evidently be between O and F′. Were they divergent, but further from O than F, their focus would be beyond F′, etc.

Action of a Biconcave Lens.—Such a lens renders parallel rays divergent, and the focus of their supposed prolongations backward is called the Negative Focus of the lens. Rays from the negative focus are rendered still more divergent. See Fig. 7.

FIG. 7.



Refractive Indices of the Ocular Media :—

Of the Cornea	1.377
Of the Aqueous Humor	1.337
Average of the Lens	1.454
Of the Vitreous	1.337

Since the two surfaces of the cornea are parallel, its refractive power is ignored, and for the sake of simplicity the refractive indices of all the media are averaged, and we thus have what is called—

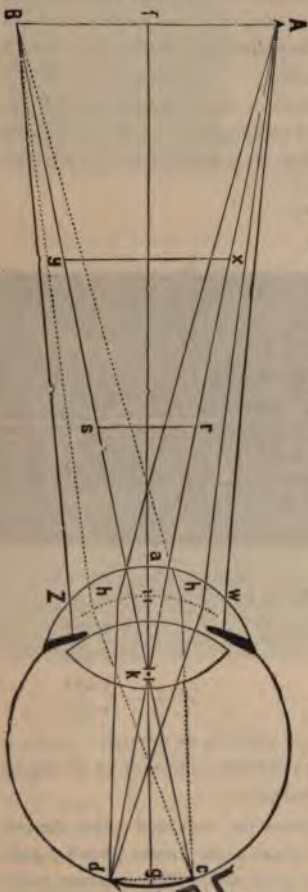
The Reduced Eye of Listing, wherein the two nodal and the two principal points are merged respectively into one, the former placed 7.4969 mm. behind the cornea, and the latter 2.3448 mm. The common index of refraction is taken at 1.3379 for the combined media.

The Size of the Retinal Image is thus easy to calculate. We must have the size of the object, and its distance from the nodal point: then it will be the size of the object, *plus* 15.1501 mm. (*i.e.*, the distance of the nodal point from the retina), and the whole divided by the distance of the object from the eye, *plus* 7.4969 mm. (*i.e.*, the distance of the nodal point from the cornea). By referring to the letters in Fig. 8 this would be expressed by the formula—

$$\frac{\mathrm{A\ B} + \mathrm{K\ g}}{\mathrm{f\ a} + \mathrm{k\ a}} = \mathrm{C\ d}.$$

Accommodation.—It was evident from our consideration of the action of a biconvex lens that the position of the focus was wholly dependent upon the position of the visible object; if this at a point, say 20 feet away, brought the rays together at the principal focus, which for brevity's sake let us call the retina, then, upon approaching the object toward the lens or eye, the focus would be formed at a point beyond the retina. All this presupposes that the refractive media of the eye is a rigid system incapable of changing its refractive power. That the eye possesses such a power we, of course, know; we call it its accommodative power. Its exercise consists in the contraction of the ciliary muscle, which lessens the tension of the suspensory ligament of the lens, allowing the anterior surface of the lens to advance by its own inherent elastic power. In this way, by the increased dimension of the lens-axis, its refractive power is sufficiently heightened to overcome the greater divergence of the rays, and their focus is still kept at the same point—the retina—as if they came from an "in-

FIG. 8.



finite distance." This elastic power of the lens is greatest in youth, and gradually grows less with advancing age, so that **the range of accommodation** decreases from childhood to about seventy years of age, when it becomes nil, and the eye is incapable of adjustment for objects nearer than infinity. The following table gives the range of accommodative power which, as a rule, each age is found to possess. The term D. (Dioptries) will be explained a few pages further on:—

Years.	*Range of Accommodation in D.*
10	14.
15	12.
20	10.
25	8.5
30	7.
35	5.5
40	4.5
45	3.5
50	2.5
55	1.75
60	1.
65	0.75
70	0.25
75	0.

Thus we see that at all ages (except extreme ones to be considered later) the position of the *p. r.* remains the same, whatever the defect. But the near point* (*p.p.*) is, with each year, being set a little further from the eye. The location of the *p. p.* for any age is theoretically determinable by dividing 100 Cm. by the range of accommodation as given in the table. Thus, at 40 years of age, we should have $\frac{100 \text{ Cm.}}{4.5} = 22$ Cm. as the distance of the Emmetrope's *p.p.* If Am.† preëxists, the amount of the defect must be added to or subtracted from the range, as will be further elucidated under Presbyopia.

Perfect Vision, therefore, demands that all rays proceeding from a point which pass through the pupil, shall be again united in a point in the retinal image. For instance, all the beams from A, Fig. 8, not, as Aw intercepted by the iris, must, after traversing the dioptric system of the eye, be reunited at d of the image C g d. The same must take place for all the rays from

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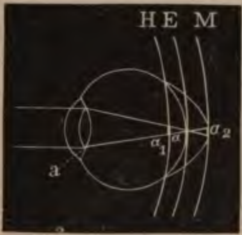
* See *Far and Near Points*, p. 18.

† See page 18.

B, and so for every intermediate point. Should they not unite except at a point behind the retina, as is shown in Fig. 9, M, then the rays from a point are, in the image, spread over a larger space than a point, *circles of dispersion* or of *diffusion*—as they are called—are formed, the image is blurred and its outlines indefinite. If the focus be imagined in front of the retina, the rays will cross and produce similar diffusion circles and indistinctness of outline results as before; see Fig. 9 H.

FIG. 9.



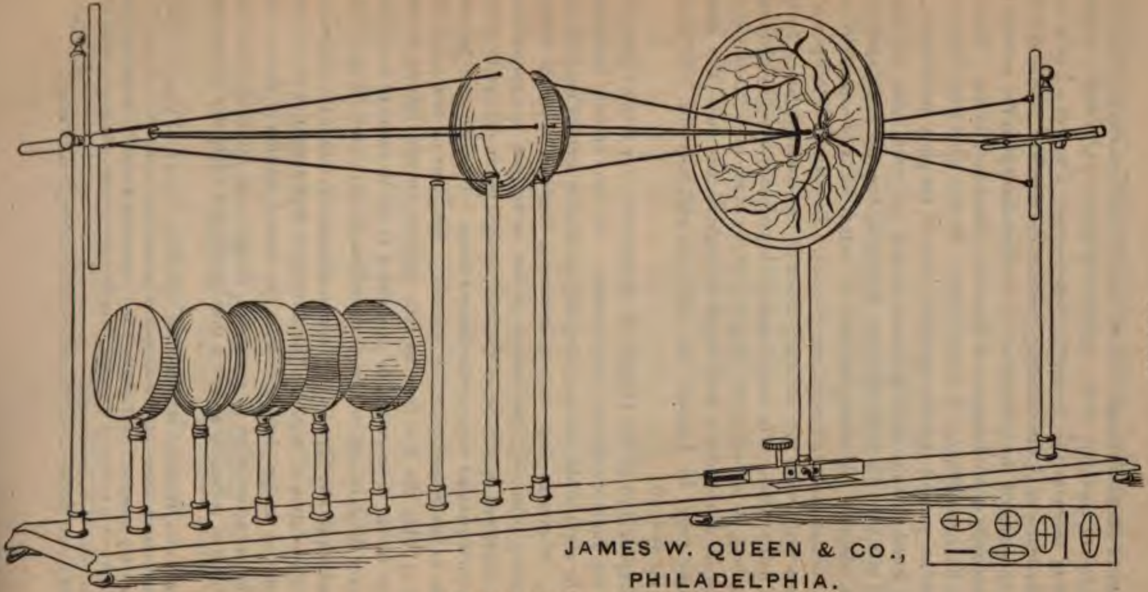
Emmetropia and Ametropia. — The emmetropic eye Fig. 9, E, is the only one having perfect vision; it reunites at the retina, all rays passing through it which proceeded from a point of the object. The ametropic eye is one not having this power, and it may vary from the normal in three principal ways:—

1. The retina may be in front of the focus, shown in Fig. 9, H, and this condition is called **Hyperopia**;
2. The retina may be behind the focus, Fig. 9, M, which constitutes **Myopia**;
3. The retina may be either in front or behind the focus, or both, but by different amounts for two or more meridians of the eye. This is called **Astigmatism**—to be explained further on.

One of the authors has planned, and Messrs. Queen & Co. have manufactured, a model designed for class demonstration of the principles of Emmetropia and Ametropia of all kinds. It is shown in Fig. 10. Its consultation will greatly aid the student in gaining an easy comprehension of the principles involved.

Far and Near Points.—When the ciliary muscle is entirely relaxed, *i. e.*, when the accommodative power of the eye is in complete suspension, the eye is then adapted for its far point. In this condition parallel rays of light (that is, from objects at an "infinite distance") are by an emmetropic eye brought to an accurate focus upon the retina. On the other hand, with the total accommodative power of the eye exerted, the distance of an object clearly seen constitutes its near point. This, as we shall see by and by, is, even for the emmetropic eye, dependent upon the age of the person. The distance between the far and near points (*punctum remotum* and *punctum proximum*, as they are called) is the **Range or Amplitude of Accommodation.** To express this we must understand the

FIG. 10.



GOULD'S AMETROPIA MODEL.

For Class Demonstration of the Principles of Emmetropia, Hyperopia, Myopia, Astigmatism, Presbyopia, the Interval of Sturm, etc., etc. Descriptive Pamphlet (to be had of the authors) explains the device and gives pertinent information.

System of Measurement.—Lenses were formerly numbered according to the radius of curvature of the surfaces* in inches, a lens with a 2-inch radius being taken as the standard. Consequently, a lens of a 5 or a 10-inch radius had $\frac{1}{5}$ or $\frac{1}{10}$ the refracting power of the standard. This, as will be seen, necessitated the constant use of fractions to express the power of a lens, especially disadvantageous in the weak glasses most in use. Moreover, the inch was different in every country. In thus numbering lenses it was taken for granted that the refractive index of the glass used was 1.5, but it is found that the index is always greater and were more properly estimated at 1.53. To avoid all these difficulties **the Dioptric system** has been adopted. A weak glass with an actual focus of one metre is taken as the standard, and called one Dioptry. Two lenses of this power, or one lens with twice the refractive power of the standard, has a focal length of half a metre. The focal length is always easily found by dividing 100 cm. (about 40 inches) by the dioptric number of the glass; thus a lens of 5 dioptrics would have a focal length of eight inches, etc. The table on opposite page, by Landolt, sets forth perspicuously the differences between the systems.

The Expression of the Degree of Ametropia may thus be given in terms of the dioptric system of measurement. We may entirely leave out of view the cause of the defect, giving only its kind in units of quantitative dioptrics. If rays of light are not accurately focalized upon the retina when coming from ∞,* the amount of that defect may be expressed in dioptries, estimated by the size of the lens required before the eye in order to bring such parallel rays to the desired focus. Thus we call an eye hyperopic to the extent of 2 D.† when a + Sph. lens of that power is required to bring the *p. r.* from its false position, beyond infinity, to the normal, as in E. Conversely, an eye with 2 D. of M. requires a — Sph. lens to carry the *p. r.* from its abnormal position, twenty inches away, to ∞.

Refraction of the Eye.—The term, consequently, means the statement in D. of the location of its *p. r.* The **Errors of Refraction** of an eye are the amounts of its Am. deviations from the normal position of the *p. r.* at ∞. The refraction of an E. eye shows, therefore, no errors of refraction. The problem of refracting an eye is thus simply and solely that of locating accurately its *p. r.*, and is called **Optometry.** Instruments for aiding in this endeavor are called optometers.

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* Not as Morton, Hartridge and others say, according to their focal lengths; so that it becomes curious to know what meanings can be attached to the words when a distinction is made between "focal lengths" and "refracting power." Hartridge, *e. g.*, says: "Each lens is numbered according to its refractive power, and not, as in the old system, according to its focal length."

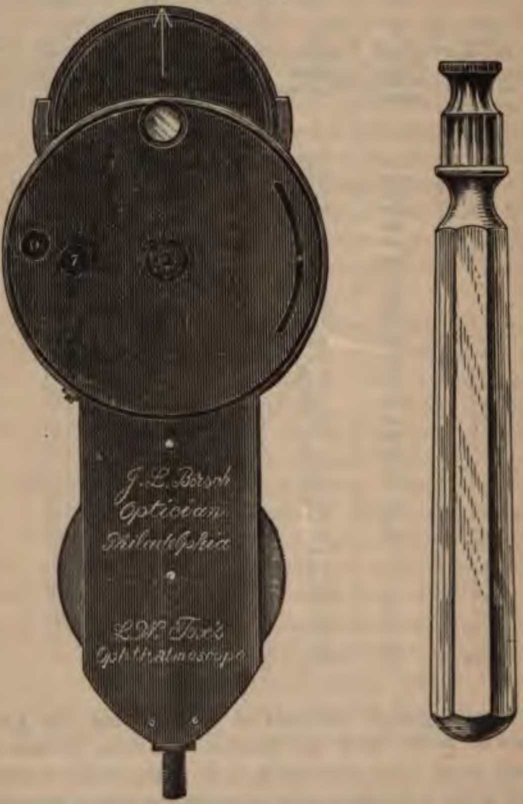
† For the sake of brevity we shall hereafter use the contractions indicated.

TABLE I.

OLD SYSTEM.				NEW SYSTEM.			
I. No. of the Lens, Old System.	II. F. Focal Distance in English inches for $n = 1.53$.	III. F. Focal Distance in Millimetres.	IV. D. Equivalent in Dioptries.	V. No. of the Lens, New System.	VI. F. Focal Distance in Millimetres.	VII. F. Focal Distance in English inches.	VIII. No. corresponding of the Old System for $n = 1.53$.
72	67.9	1724	0.58	0.25	4000	157.48	166.94
60	56.6	1437	0.695	0.5	2000	78.74	83.46
48	45.3	1150	0.87	0.75	1333	52.5	55.63
42	39.6	1005	0.99	1	1000	39.37	41.73
36	34	863	1.16	1.25	800	31.5	33.39
30	28.3	718	1.39	1.5	666	26.22	27.79
24	22.6	574	1.74	1.75	571	22.48	23.83
20	18.8	477	2.09	2	500	19.69	20.87
18	17	431	2.31	2.25	444	17.48	18.53
16	15	381	2.61	2.5	400	15.75	16.69
15	14.1	358	2.79	3	333	13.17	13.9
14	13.2	335	2.98	3.5	286	11.26	11.94
13	12.2	312	3.20	4	250	9.84	10.43
12	11.3	287	3.48	4.5	222	8.74	9.26
11	10.3	261	3.82	5	200	7.87	8.35
10	9.4	239	4.18	5.5	182	7.16	7.6
9	8.5	216	4.63	6	166	6.54	6.93
8	7.5	190	5.25	7	143	5.63	5.97
7	6.6	167	5.96	8	125	4.92	5.22
6½	6.13	155	6.42	9	111	4.37	4.63
6	5.6	142	7.0	10	100	3.94	4.17
5½	5.2	132	7.57	11	91	3.58	3.8
5	4.7	119	8.4	12	83	3.27	3.46
4½	4.2	106	9.4	13	77	3.03	3.21
4	3.8	96	10.4	14	71	2.8	2.96
3½	3.3	84	11.9	15	67	2.64	2.8
3¼	3.1	79	12.7	16	62	2.44	2.59
3	2.8	71	14.0	17	59	2.32	2.46
2¾	2.6	66	15.1	18	55	2.17	2.29
2½	2.36	60	16.7	20	50	1.97	2.09
2¼	2.1	53	18.7				
2	1.88	48	20.94				

Of the many ingenious **Methods of Ascertaining the Errors of Refraction** of an eye many are objectionable, either because of their complicated nature, their requirement of too high a grade of intelligence or of visual acuity in the patient, the expensiveness of the instruments, etc., or for other equally valid reasons. We shall, therefore, limit ourselves to the few methods which in practice are found most easily and reliably carried out. Specialists may have their preferences, some preferring the one or the other of these methods, or supplementing them by other methods we shall but briefly mention or entirely pass over, as being not adapted to the every-day practical needs of the student or general practitioner, for whom this manual is intended. For such it will suffice, as a general rule, to master the following two means: 1, *that of the ophthalmoscope;* and 2, *that of the test lenses.*

FIG. 11.



The Ophthalmoscope is an instrument which requires considerable dexterity and patience on the part of the student to learn its use; not only this, but an extended period of usage is afterward required to learn one's own visual defects or peculiarities, and to gain that experience and knowledge, both of the normal and the pathological fundus, requisite to accurate diagnosis, either of refractive errors or indications of general disease. Considering these facts, as well as this of its possible value in the hands of the general practitioner as an aid in the diagnosis of general pathological conditions, it seems strange that its use is so limited, or only entered upon at a late period of study or practice.

The simplest form and the essential principle of the ophthalmoscope is shown in a bit of mirror or silvered glass with a hole in it. If the observer's eye and that of his patient are nearly E., this instrument is quite capable of giving one a good view of the fundus. But as most eyes are not normal, absolutely speaking, in their refractive power, + Sph., or — Sph., lenses are required to be interposed to neutralize the errors of refraction. The numberless forms of ingenious, simple or complicated, cheap or expensive, ophthalmoscopes are only devices for throwing these neutralizing lenses between the observer's eye and the reflecting mirror, or for hinging the mirror at the angle desired, so as to throw the light most advantageously through the pupil of the observed eye. An instrument invented by one of the authors combines, as we think, the best features of other instruments, with the demand for ease of use, accuracy and reasonable inexpensiveness, in a happy way. Especially commendable are the novel features of throwing the lenses by means of the toothed wheel near the handle, the rotation of the mirror at any angle, the number and arrangement of the lenses, etc. It is shown in the annexed cut (Fig. 11).

The Principles and Conditions of Ophthalmoscopic Refraction.—The chief law made use of in ophthalmoscopic examination is the self-evident one that rays reflected from the fundus emerge from the eye in the same direction as the entering rays; the refractive media of the eye exercise the same action upon the light, whether passing in or out of the eye. As ordinarily seen the pupil is black because there is no light reflected into the observed eye from our own; but, making our eye an artificial source of light by the ophthalmoscopic mirror, the returning rays from the observed eye enter our own eye through the hole in the mirror. Now if our own eye be emmetropic, *i.e.*, if it focalize accurately parallel rays, it is evident that we shall see the observed fundus clearly if rays reflected by it emerge from the observed eye in parallel lines,—*i.e.*, if it also be an emmetropic eye. This method of estimating the patient's refraction starts out with the prerequisite that the physician know his own, and he may be ametropic either permanently or temporarily; if organically ametropic an estimation of the kind and amount must be made for him by a competent person, and this becomes his "personal equation," to be allowed for in every case of refraction he will have to estimate. For it is apparent that if he have, say, 2 D. of M. himself it must be added to the patient's Am.

Not only may the physician thus have a permanent error to allow for, but there may be another, though temporary, source of false estimate in the exercise of his own accommodation—which is not required or desired. Beginners always make the natural mistake, knowing the object or fundus to be an inch or more from their own eye, of exercising a powerful convergence and accommodation, in order to see such a close object. The constant exhortation to such a one thus becomes the familiar, "*Relax your accommodation*," and various and complicated instructions are given him how this may be done. The simplest way is for him to persistently imagine himself to be looking at an object at least twenty feet off. The reader now knows that rays from an object thus removed are, practically speaking, parallel, and that an emmetropic eye accurately focalizes such rays when at rest. Nearer objects send divergent rays into the eye and so accommodation is required to still focalize them correctly. But in examination with the ophthalmoscope, we want an objective and exact measurement (by the lenses) and not a subjective and indeterminate one. Hence the necessity for a trained passivity on the part of the physician; his eye must nota ct accommodatively on the received rays. If it do not, then it is perfectly clear that the lens required between the two eyes, for the clearest vision of the observed fundus, becomes the exact measure of the patient's Am. —*provided always* that the patient's accommodation is relaxed. This is quite completely effected by his fixation of the gaze upon the black wall of the dark room, but far more certainly by the use of a mydriatic.

Practical Procedure.—The patient sits or stands in a room with blackened walls and excluded daylight, in such a position that the light of an Argand burner shall strike the temple from behind and to the side of the eye to be examined, while the eye itself is in shadow. The physician stands on the side and a little in front of the eye to be examined, and with the mirror properly adjusted to reflect the light from the burner into the pupil; he then directs the patient's gaze to the wall, and, with his right eye to the patient's right, or left to left, he looks into the pupil at about an angle of 15° with the patient's visual axis. Obtaining a luminous reflection through the observed pupil, he advances the instrument held close to his own eye, to within half an inch of the patient's eye, endeavoring to keep the fundus reflex always in view. With a little patience and manipulation the image of the fundus will swim into view. It is best to estimate the refraction by fixing the choroidal epithelium, or the smallest capillaries, at or near the temporal edge of the papilla. The lenses of the instrument are now thrown into place one after another, until one is found which gives the clearest and sharpest outlines to these objects, and this, if the previously-mentioned conditions have been observed, indicates the kind and amount of the patient's Am., because it will give the location of his *p. r.* in dioptric units. If a — sph, lens of 2.5 D. be required to distinguish the finer details of the fundus, it follows (if the accommodative powers of both the observed and observing eyes have been wholly suspended), that the observed eye has its *p. r.* at a point 2.5 D. nearer than ∞, that is, at 16 in. instead of 20 feet away. In case a + sph. glass is required it shows that the patient's *p. r.* lies at a point so far beyond ∞ that this additional refractive power is required by his eye to give the rays their proper focalization upon the too-closely placed retina. Figs. 12 and 13 illustrate these conditions; in the first, the + sph. is required to give the divergent rays emerging as if from a point beyond the retina, the parallelism of E., and in Fig. 12 the convergent rays coming from the myopic eye and proceeding to a not distant focus, require a — sph. lens to render them parallel. An ametropic eye cannot focalize parallel rays properly, and so such an eye never can render its emergent rays parallel. Parallelism of the emergent

FIG. 12.

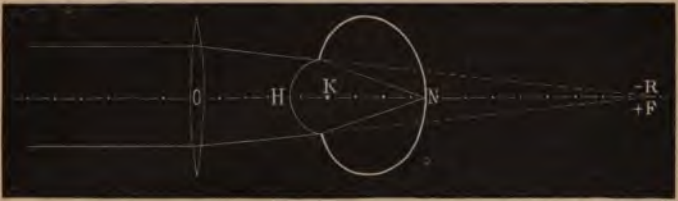
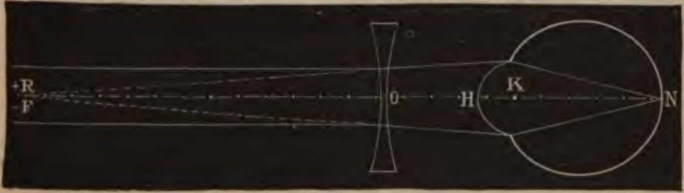


FIG. 13.



rays, therefore, indicates E., or the *p. r.* properly placed at ∞, and the lens required to render such emergent rays parallel is the exact measure of the Am.*

The Estimation of Am. by the Test-letters and Test-lenses.—This, resting on the patient's acuteness of vision, is by far the most reliable and most used method of estimating refractive errors. It requires a well-lighted room 20 feet long, a card of distance test-letters, and a case of test-lenses. Let us briefly describe these requirements and the reasons they are needed:—

Twenty feet of space is required, because rays from an object at that distance are found to be nearly enough parallel to require little or no exercise of the accommodation on the part of an E. to focalize them correctly. Light from nearer objects calls the accommodation into action, and, whether a mydriatic be used or not, this is not, of course, admissible, when our object is to localize the patient's *p. r.*

Test letters for distance are constructed on the following principles: It is found that the average of normal visual acuity is such that a distant object subtending a visual angle of five minutes is accurately discernible. Snellen's letters are most used, and those subtending this angle at a distance of 20 feet are, therefore, the ones most serviceable, while still larger ones, filling the same angle at 30–40–50–70–100–200 feet away, are also printed upon the same card, in order to test the subnormal acuity of amblyopic or Am. eyes. Thus, if a patient at 20 feet can only read the letters which should be read at 100 feet, we say he has only one-fifth the normal visual acuity, expressing the fact thus: $V. = \frac{20}{100}$. If a patient read $\frac{20}{20}$, it is certain he is not M., but it by no means implies normal visual acuity, for he may be H. or As. and may be overcoming the defect by his accommodation; hence the necessity of using a mydriatic under the circumstances and conditions to be enumerated later.

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* This is called the **Direct Method**, giving one an erect image of the fundus. By the **Indirect Method** we get an inverted image of the fundus. We use a 9-inch concave mirror, of about 2-inch diameter (the retinoscopic mirror), and placing the patient a little in front and to one side of the light, reflect into the pupil an image of the flame, while we look through the perforation in the centre of the mirror. Standing about a foot away we interpose a + Sph. 20 D. lens before the eye, resting the little finger on the patient's forehead; the aerial inverted image now formed is larger in H., and smaller in M. than in E. If upon moving the lens back and forth we find the image of the papilla round and remaining of the same size the eye is E. Advancing the lens causes an increase of the papilla in size, in M., and a decrease in H. In As. the disk will have an oval appearance.

The physician's eye is supposed to be E.

The Case of Test Lenses should contain full sets, in pairs, of + Sph. and — Sph. lenses, from 0.25 D. to 20 D.; of + Cyl. and — Cyl., from 0.25 to 6 D.; a set of prisms, colored and ground-glass disks, etc., etc., with a trial frame.

When should a Mydriatic be used?—This is a momentous question, ophthalmic surgeons, in their opinions and practice, differing widely. For ourselves we answer: Never after forty years of age, generally before. To be more specific, two reasons unite in limiting its use to this period of life: in the first place, it is found that if used in eyes above the age given, it has a tendency to develop, in a certain proportion of cases, the terrible disease, Glaucoma. The general practitioner has been known to err in this respect, and by the use of atropia has developed a thousand times worse disease than he sought to cure by it. Moreover, the annoyance to the patient may be obviated by the fact that after this age the decrease in the range of accommodation has become so great (see p. 51) that it vitiates but little the general correctness of the estimation of errors.

That the mydriatic should generally be used in younger eyes arises from the uncertainty of all results obtained without its use. However troublesome and vexatious its use both to surgeon and patient, we do not hesitate to say we should generally consider we had not done our duty to the patient if we had not used it. Fine degrees of astigmatism cannot certainly be diagnosed by the ophthalmoscope, and both these and exact or low quantities of other Am. errors are fruitful sources of asthenopia and imperfect vision in our nervous and sensitive people. We can, of course, arrive at approximately accurate results otherwise, but approximations are not certainties; guesses may not, cannot, be exact. The little uncorrected As. may be the greater cause of the patient's complaint.

It is obvious that its use is less necessary in high degrees of Am. than in low ones, less necessary in M. than H.; so that, while the rule holds good, as a rule, sound judgment must here, as everywhere, be master of the rule and may set it aside in many cases.

Mydriatics and their Use.—The most used, and the one, as a rule, to be recommended, is the Sulphate of Atropia, to be used *t. d.* for one or two days prior to the examination. We find that gr. j to aquæ, ℥ iij gives about the strength required. The objection to atropia is the time required for its effect to wear off, the full Acc. not returning for about a week or ten days after stopping its use. For this reason the Hydrobromate of Homatropine is used, its action being more prompt, and the effect passing off within twenty-four hours. It is, however, a much more expensive drug than the sulphate. The best strength is that of gr. iij to ʒ vj, and its frequent instillation is required to produce certain suspension of Acc. Dropped into the eye every ten minutes for the hour preceding the examination produces the desired effect generally.

For the sake of comparison and precision it is found advisable to repeat the examination at different times, best of all upon successive days; in which case, unless the loss of time and annoyance of the patient forbid it, the Atropinæ Sulph., as first advised, becomes the preferable drug.

Practical Procedure with the Test Lenses.—We postpone, as before, the consideration of Astigmatism, and suppose the patient's error to be one of uncompounded H. or M. His Acc. is neutralized and we adjust the lens frame, commencing the examination with the left eye covered by the ground glass or opaque lens. Beginning with the largest Snellen letters (twenty feet away), we ask him to read down the card. The last line he reads correctly is the measure of his Am.; let us suppose it to be the one which should be read at fifty feet; we note on the record, R. V. = $\frac{20}{50}$, and proceed to apply lenses just as we did with the ophthalmoscope. We first use a + Sph. (so that any remnant of Acc. may not be called up) of low power, say 0.50 D., and if the acuity of vision is improved by it (if the patient see more clearly, or further down the card), we know he is H. and that we are on the right track. We continue with higher numbers of + Sph. lenses till that one is found giving him V. $\frac{20}{20}$ with clearness and ease. We then proceed with the left eye in the same way. But if + Sph. renders vision worse, we change to — Sph. and find the glass with which $\frac{20}{20}$ is distinct and clear. If in the first case a + Sph. 1.50 D. lens was required to give him normal acuity, we add to our record already made the additional item, so that for the day his record for this one eye would read, R. V. = $\frac{20}{50}$ Sph. + 1.50 = $\frac{20}{20}$. If, instead of this, — Sph. 1.75 D. was the lens giving normal acuity, we note the fact in the same way. The strongest + Sph. which gives $\frac{20}{20}$ clearly is considered the measure of the H., while the weakest — Sph. is the measure of the M.

We may, at the second examination, prescribe the spectacles to be worn, if the results are the same as in the first; but if they are different, it shows that the patient had erred in his answers, or that his Acc. yields only stubbornly to the mydriatic, and yet other examinations are requisite for precision. Rules for prescribing will be considered under the treatment of each form of Am.

Other Methods of Optometry, having a supplementary, exceptional, or theoretic value and interest, may be briefly described. They are those by Retinoscopy, by Tweedy's Optometer, Thomson's Ametrometer, Thomson's Modification of Scheiner's Experiment, *etc.* Of these the most "popular" is probably that first named.

Retinoscopy is a lately-arrived child of Ophthalmology which the not over-fond parent finds a difficulty in naming. "The Shadow Test," "Keratoscopy," "Pupilloscopy," "Skiascopy," "Phantoscopy," "Koroscopy,"—these and others find only exceptional acceptance with its sponsors. Let us close with the one chosen above! Another peculiarity that may be mentioned is that the method is universally described as "popular," yet each surgeon so describing it does not use it much himself. The reasons for this appear best upon trying to practice it. It is not easy to learn, nor easy to execute when patience and skill have conquered the difficulties; its indications are indefinite unless the test-case of lenses be carried into the dark room, which is vexatious, and yet more so to work with the lenses in the obscurity.

The method, however, may be of undoubted advantage and use in cases of illiteracy, stupidity in young children, in high amblyopia, and sometimes in the hospital army of the "great unwashed" where the propinquity demanded by the ophthalmoscope is not inviting.

Practical Retinoscopy.—The light should be a little above and behind the patient's head; the pupils should be dilated. The physician sits about four feet in front of the patient and, with a 9-inch concave mirror, about two inches in diameter, he throws the reflected light into the observed eyes. If a plain mirror be preferred the indications or movements of the fundus reflexes are the reverse of those to be given. Through an ophthalmoscopic perforation in the centre of his mirror the examiner observes the movements of the luminous reflex sent back from the fundus through the pupil, as he turns the mirror slightly about its vertical or its horizontal diameter. These movements are different in character for each kind and for every degree of Am.

The general but indefinite and immeasurable indications are these:—

The more blurred the reflex
The less sharply defined its edges,
The duller the illumination
The slower the movement
The more curved the bounding shadow line
} the greater the Am. whether H or M.

The definite and measureable indications are these:—If the luminous reflex[*] move *with* the revolved mirror (*i.e.*, if by turning the vertical axis so that the right-hand side of the mirror advances, and this is followed by a movement of the reflex from our right to left), the patient is certainly M. by as much as 1 or more D. We can measure the amount of the M. approximately by placing in front of the patient's eye — Sph. lenses till one is found with which the reflex ceases to move *with*.* The patient's M. is then still greater than this lens because we, or rather the focus of our mirror, is about a metre from the patient's eye. We, therefore, add to the lens — 0.50 or — 0.75 D.,—not a full D. for fear we should over-correct—and this is not far from the measure of his M.

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[*] Commonly called "shadow,"—why so we could never understand, having always held and taught that it was light we saw, and not shadow. We are glad to find a confirmation of our view by Landolt (*Refraction*, etc., note p. 274.)

But if the fundus reflex, instead of moving with, be found to move *against*, either one of three different results may be found true; the patient may be H., M. in a low degree,—less than 1 D.,—or, he may be E. To ascertain if it be certainly H. with which we have to do, we put up a + Sph. 1 D. lens; if with this the movement be still *against* we have H. and we proceed to add + Sph. lenses until, as before, we find one with which no movement is detectable; then the H. may be estimated as about 1 D. weaker than this lens.

But, suppose, after putting in the Sph. + 1 D. lens, the movement becomes one *with* the mirror, then our possibilities have been reduced to two, Low M., or E. By displacing the + Sph. 1 D. by a + Sph. 0.75 D. lens we settle which it is: if the movement then become *with*, we have E.

A test of the supposed proper lens consists in moving the mirror further from the patient, when, if the movement *with* appear, it shows the emergent rays are not rendered parallel by the lens, and a weaker one will have to be put in its place.

The rationale of these movements is easily discerned by the student who remembers that the rays emerging from an E. eye are parallel, those from an H. eye are divergent, and those from a M. eye convergent. The movement of the reflex with or against depends on whether the emergent rays cross before meeting the observer's eye; if they do, they form, of course, an aerial image (inverted) of the retina, which must, of course, move *with* the mirror. — Sph. lenses finally transpose this image behind the observer's head and the movement becomes against, as it must be in E., H., or those low degrees of M. in which the aerial image is behind the physician.

The movements indicative of As. will be mentioned under that head.

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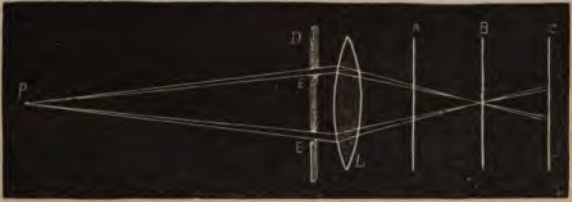
* Or, we can continue putting up higher numbers until one is found with which the movement becomes against. If this be the *weakest* one producing this effect, it is itself the approximate measure of the M. without deductions. In H. we can, in the same way, stop at the *strongest* with which we get any reverse movement.

Professor Thomson's Modification of Scheiner's Experiment is most ingenious and interesting, deserving mention, and a greater vogue than it seems to have. The famous "Experiment" of Scheiner consisted in observing an object through two pin holes (in a visiting card, for example), which were a little nearer each other than the diameter of the pupil. In an E. eye the two rays of light which pass through the pin holes will be united on the retina and so produce a single image, as is shown at B (Fig. 14). If the eye be H., the rays reach the retina before crossing and produce two images, as is shown in the figure when the retina is supposed at A. If the eye be M., the rays will have crossed and again produce two (reversed) images, as at C. Professor Thomson finds the *kind* of Am. by slipping a colored glass over one of the pin holes, and the patient's location of the colored and white images shows at once whether it be H. or M., as may be seen by reference to the figure above. If the "E." ray be colored and the patient say the upper image is colored, we know we have H.; but if it is the lower image that is colored, we have M.

FIG. 14.



The amount of Am. is measured by the separation of the two images, and this is arrived at by placing two small flames twenty feet away, one behind the other, so that both would be seen by an E. as one, though to the patient's eye, looking through the two pin holes, two images are produced, one above the other. Then the second flame is raised till it corresponds with one of the images of the first flame. The distance which the second flame has to be raised is the measure of the Am., a scale or a table of which can be constructed from experience or mathematical calculation. Instead of bringing a second flame in to measure the distance of the images, test lenses could be placed before the eye till the two points flowed together. For the *illiterati* "and the rest" this method is decidedly commendable. Another method of Professor Thomson, by which Am. may be estimated, is shown on p. 44, Fig. 19. We have now cleared our ground sufficiently to allow us to examine more in detail the principal clinical forms of Am.

HYPEROPIA.

Synonymous with Hypermetropia.

Definition.—That condition of the eye in which parallel rays of light are, with suspended accommodation, brought to a focus beyond the retina, by the dioptric system.

Varieties.—*Manifest*, whose measure is the strongest + Sph. lens, giving, without Atropia, the greatest acuity of vision. The *Latent* is only revealed by the use of the mydriatic. Both together constitute the total H.

Etiology.—The globe may be shorter in its antero-posterior diameter than the normal average, while the refractive power of the media are normally strong. This is by far the commonest cause; it is called Axial H. On the other hand, the length of eye may be normal while the refractive power of the media may be subnormal, and this diminution of refractive power may be produced by several causes, among which are a lessened convexity of the refracting surfaces, a change in the Index of Refraction of media, a loss of the lens (see Aphakia); in old age the lens becomes flatter.

The ultimate cause of H. is considered to be an arrested development. Animals are generally highly H., while savages are, as a rule, more or less so. Children are H., and become E., or even M., while growing to maturity. It might, therefore, be looked upon as a reversion to the natural type of eye, or, more correctly, as a failure to take on the increased Acc. of civilization, the excess of whose influence is painfully apparent in the increase of M., almost exactly proportional to the number of school years of the child. It is largely hereditary. The excessive use of the ciliary muscle in H. produces an abnormal development of that muscle, especially of that division known as Müller's annular muscle.

Correspondence between Axial Shortening and H.—

H. in D.	*H. Axis in Mm.*	*H. Defect in Mm.*
0	22.824	0.00
1	22.51	0.31
2	22.20	0.62
3	21.90	0.92
4	21.61	1.21
5	21.32	1.50
10	20.04	2.78
15	18.91	3.91
20	17.92	4.90

Symptoms.—There are certain objective signs by which the experienced observer may sometimes get indications of H. The globe is generally undersized and mobile; its ellipsoidal flattening may be seen, if sufficiently great, by exposing the side in extreme convergence. H. not seldom coexists with a short head and flat face.

Subjective symptoms are still more reliable; the leading complaint will, of course, be of the inability to keep up continuous close work. The letters and words of the reading run together, or the sewing blurred; asthenopia ensues; lachrymation and pain in and about the eyes; headache; dullness and heaviness of the eyes and of the lids, will all be spoken of. The palpebral conjunctivæ may be found injected, the edges of the lids hyperæmic, and even granular lids may be superinduced. Vision for distance will be good, because the ciliary muscle is still able to produce sufficient Acc. to focalize parallel rays upon the retina. But as a large part of its power is spent in this labor, it has so much the less remaining to apply to the work of focalizing rays of greater and greater divergence. Hence, after exercising the extreme of its power on near objects, the ciliary muscle becomes exhausted and strikes work. If still forced to its unequal task, the strain put upon it spreads to surrounding tissues, whose affections are thus often due to simple uncorrected errors of refraction.

Connection Between H. and Convergent Strabismus.—There is a general law, subject to quite a range of deviating exceptions, that accommodation increases with convergence. The nearer the object, of course, the greater the converging force exercised by the two internal recti muscles, and the greater the action of the ciliary muscle. Now the great accommodation required in H. of a medium high degree tends to produce a greater convergence than is required for the just fixation of the object by the visual axes. If, now, there exist any inferiority of one eye, either of visual acuity, or of muscular strength of the counteracting external rectus, the force of the innervation (otherwise equal in both eyes) expends itself in proper fixation of the superior eye and in excessive convergence of the less valuable eye. The eye having the greater degree of Am. is also the one thus thrown out by this struggle for the field. If both eyes are equally valuable and strong a lengthened period of alternating strabismus may follow, neither eye gaining the mastery. Both phenomena occur in childhood, and require scientific attention early, so that the converged eye may not become highly amblyopic, or even blind, from lack of exercise. It has been estimated that over three-fourths of all convergent strabismus is caused by H. (The student is further referred to the treatment of convergent strabismus, p. 59.)

Myopic Simulation of Hyperopia.—In high degrees of H. it may happen that M. symptoms supervene. The patient in these cases has to choose between a small retinal image with distinctness, and a large image blurred by circles of diffusion. In choosing the latter, to him the lesser of the two evils, he will, *e.g.*, hold the book or paper as near his eyes as if he had an extreme M. Ciliary spasm may also complicate the diagnosis; when this abnormal condition exists the focus of parallel rays may be brought in front of the retina and thus a weak — Sph. lens seem to the patient to give relief. In misreading these symptoms surgeons sometimes make grievous errors, and the mistake is the more likely to happen with those not using a mydriatic in refraction. When this trouble is possible or suspected thorough subjection of the muscle by atropia uncovers a world of difficulty.

Increase of H. in Old Age.—By reference to Fig. 20, p. 51, it will be seen that the E. begins at about 55 years of age to become H. This change is distinct in kind and character from Presbyopia, and is occasioned by the increased refractive power in the cortical laminæ of the lens, rendering the lens more homogeneous, and so, as a whole, less refractive than in youth. At the age of 80 this lessened refractive power amounts to over 2 D. If H. existed previous to this change, it makes the total H. that much more. If M. preëxisted, it neutralizes the H. change. The presbyopic change, as will be seen, begins earlier, and to this the H. of old age is superadded.

Diagnosis.—An infallible quantitative diagnosis is, as we have said, impossible without the Acc. have been neutralized by a mydriatic. A failure in the normal acuity, as evidenced by testing with the distant letters, may be due to inherent amblyopia, to spasm of the ciliary muscle, or to a complicating As. If famous surgeons say they can detect these causes and accurately estimate their quantities by the ophthalmoscope, we do not assuredly *express* our disbelief; we simply continue to advise the younger master to make assurance doubly sure by the instillation of a mydriatic for two days prior to the examination. This having been done, the acuity of vision is tested by the distance letters of Snellen, and a careful ophthalmoscopic examination then supplemented by the more rigid and exact method with the test-lenses, as heretofore described. Confirmations of the results worked out may, if desired, be sought by Prof. Thomson's method or by retinoscopy. The mydriatic should be continued, and the examination repeated a second, or (if the results are then contradictory) a third time, on succeeding days.

Treatment.—Prescribe the *proper* spectacles; see p. 46.

Aphakia.—This condition is caused by the absorption, luxation or removal of the Crystalline Lens. There fractive action of the lens is equal to that of about 10 or 11 D., so that after its extraction the eye requires before it a spectacle-lens of this power to compensate for its absence. If there were, previous to the absence of the lens an Am., its amount must be added to that of the correcting glass. If there had been three D. of H. the total correction would, therefore, be a 13 or 14 D. + Sph. glass; if 3 D. of M., so much less. In one remarkable instance one of the authors removed the cataractous lenses from both eyes of a patient, giving her at once perfect vision without any spectacles, showing that the eyes were previously M. by about 10 D. The refraction of the aphakial eye is estimated by the test-lenses and distance letters. As there is to such an eye no Acc., it follows that for near work, or reading, still stronger + Sph. glasses are required. These may be estimated by the Jaeger test cards, and will generally be found to be about 3 D. stronger than the distance requirement; these should be prescribed as a separate pair of spectacles.

MYOPIA.

Synonymous with near sight, short sight, Brachymetropia (Donders).

Definition.—That condition of the eye in which parallel rays of light are, with suspended Acc., brought to a focus in front of the retina. The *p. r.* is between the patient and ∞.

Varieties.—I. *The Typical*, which includes the lower degrees, is generally slowly progressive in childhood and youth, becoming stationary in early adult years, and is unaccompanied by marked changes and lesions of the fundus; II. *The Malignant*, including the high degrees, usually progressive and which is commonly accompanied by extensive lesions of all the posterior portions of the globe.

Etiology.—In the lower forms of the affection the length of the ball may be normal and the M., therefore, due to abnormal curvature of the cornea, excessive refractive power of the media, *etc.*, but the vast majority of M. is undoubtedly due to an increased length of the globe, called axial M.

So long as the M. is typical, or what might with permission be called normal, the determining cause may be set down as Nature's adaptation of means to ends. The phenomenon becomes a remarkable corollary of the survival of the fittest. Animals are decidedly H., savages less so or with the precision of E., possible, while the highly civilized man is rapidly becoming M. The greater the civilization, the greater and more persistent the Acc. and convergence of the visual axes upon near objects, and the eye, like any other organ, is adapting itself to the work required of it. Tscherning found the percentage of M. in males of one age to be as follows: For day laborers, etc., 2.45; mechanics, 5.24; mechanics engaged on near work, 11.66; artists, engineers, etc., 13.33; merchants, 15.76; professional men, 32.38.

But this relatively speaking normal M., is not uncommonly followed by the progressive or malignant type, invading the ocular membranes and resulting in dangerous morbid phenomena and extreme degrees of M. Elongation of the ocular axis is the direct cause of the M. As to what causes this axial increase, it is of course directly due to the constant or abnormally-increased intraocular pressure. The giving way of the posterior membranes, notably the sclerotic, constitutes the posterior staphyloma which is the immediate cause of the high M. Whether the posterior staphyloma be the result of normal or of excessive intraocular pressure, it is because this portion of the sclerotic must be weaker than the other parts. That in the normal E. eye it is weaker, there can be no doubt. Tenon's capsule and the staying functions of the muscle and their insertions give greater support to the middle and anterior portions of the globe. It is almost universally found that choroiditis accompanies the staphylomatous formation, as would be natural from mere mechanical reasons. The question arises: Does the choroiditis precede the staphyloma or follow it? If the first, then the choroidal inflammation, both by weakening the sclerotic, with which it is in contact, and by increasing the intraocular tension through the resultant exudations and œdema of the tissues, is the ultimate cause of the staphyloma and its attendant M. If the choröidal inflammation follows the giving way of the posterior membranes, then the cause must be sought in the reason for the increase of tension, or for that weakness of the sclerotic which makes it incapable of withstanding the normal intraocular pressure. Investigation has not yet settled this important question. Probably both causes are operative either singly or in conjunction. It is not improbable many cases of glaucoma arise from rigidity of the sclerotic; in earlier years, when the sclerotic is more yielding, it gives way to the lesser extremes of pressure, and the result is posterior staphylomatous formations, which might have developed into glaucoma instead. Compression of the eyeball by the extrinsic muscles is also adduced as a not improbable cause of the posterior ectasis.

M. is hereditary as well as acquired, and if the children of M. parents are not always M., the predisposition is more certain in such.

Excess in Length of the Myopic Eye.—

M. in D.	*Length of M. Eye.*	*Excess in Length, mm.*
0	22.824	0.00
1	23.14	0.32
2	23.48	0.66
3	23.83	1.01
4	24.19	1.37
5	24.56	1.74
10	26.62	3.80
15	29.10	6.28
20	32.13	9.31

Ophthalmoscopic Revelations and Pathological Anatomy.—The "myopic crescent" is always found in the higher degrees of M. This is accompanied by a drawing over of the retina on the nasal side, which is the side opposite the staphyloma. The sclerotic bulging causes the crescent by the pigment layer being drawn away from the papilla, and the white sclerotic being thus uncovered. White spots may appear in other parts of the fundus, hemorrhages may occur, the papilla will show partial atrophy, and exudation material from the choroidal inflammatory process be thrown out, to be finally followed by possible retinal detachment or continuous atrophy of the chorio-capillaris. The tissue changes may finally extend to the ciliary body and anterior structures. The general facts of the tissue changes in and about the papilla all show them to be consequent upon a pressure upon these posterior membranes, which become distended, the bulging including the optic nerve, which becomes kinked or obliquely placed, whence follows the separation from its sheaths, hemorrhages, and atrophy.

Symptoms.—What we have called the normal development of M. takes place in youth, the eye obtaining its permanent form in early adult life. The malignant type, during this process, may supervene at any time, according to the determining causes or the strength of the predisposition. The patient complains of inability to see distant objects plainly. In the more extreme degrees all the symptoms follow which would be expected from the tissue changes of the fundus oculi: scotoma, photophobia, photopsia, muscæ volitantes, hyperæmia of the lids and conjunctivæ, pains in and about the eyes. The M. eye is generally prominent, not seldom ovoid, the pupils large and inactive.

Connection of M. and Divergent Strabismus.—In the same way as H. is often followed by convergent strabismus, so M. tends to produce the divergent variety, because of the inability of the internal recti to keep up the persistent convergence consequent upon the *p. r.* being so near.

Diagnosis.—The — Sph. lens required to read $\frac{20}{20}$ is the measure of the M., with suspended accommodation. There is here less need of a mydriatic than in H. and yet we can never be sure that uncorrected As. does not remain to become a fruitful source of trouble in the future. The ophthalmoscope may be called in to aid or confirm the diagnosis, as also the other methods of optometry mentioned before.

Treatment consists: I. in prescribing proper spectacles (see p. 49). In the malignant forms such measures are to be instituted as will be considered under Choroiditis. Paracentesis of the anterior chamber is advised, to relieve the intraocular pressure, though all remedies are comparatively hopeless. II. Such prophylactic measures as the case demands must be insisted on. These are to read, write or study in as erect a position as possible, to avoid congestion of the ocular tissues consequent upon stooping; to have good light; to keep the work at a good distance from the eyes—12 to 15 inches, and to give the eyes frequent intermissions of rest; general health and hygiene are, of course, to be considered. All physicians, school visitors, and parents should demand proper desks, light and ventilation in schools. For it is during the period of school-life that the youth develops this malady which even in its slightest forms makes him a perpetual slave to spectacles, and which may easily pass into more dangerous phases. It is a popular fallacy that the M. eye is stronger and better than an E. one. Its only possible advantage is in postponing a few years the use of presbyopic glasses by wearing — Sph. for 20 or 30 years previously—a sorry compensation!

ASTIGMATISM.

Definition.—That condition of the eye in which homocentric rays of light (whether convergent, parallel, or divergent) are brought to different foci. It has, therefore, no relation to the length of the eye, only to the unequal refracting power of the media.

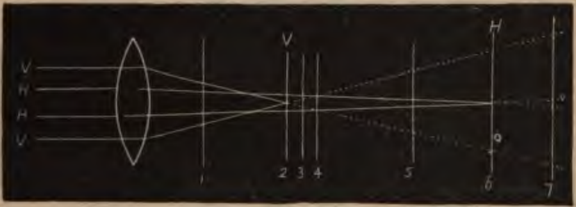
Varieties.—I. *Regular*, when the two meridians of greatest and least refractive power are at right angles to each other. II. *Irregular*, in which different parts of the same meridian have differing refractive powers. Minor divisions of these will be considered in the following pages.

Etiology.—Irregular Astigmatism is either Corneal or Lenticular. If due to imperfection of corneal rotundity it is caused by injuries, wounds or surgical operations which have marred its symmetry, or to ulcers of the cornea producing the same result; that protrusion of the cornea called conical cornea (*q.v.*) may produce the same effect. If the lens is at fault it shows a different refractive power in different sectors of that body.

All of these defects are with difficulty or not at all amenable to therapeutic agencies, and are but a very small proportion of all cases of As. They need not, therefore, be further considered.

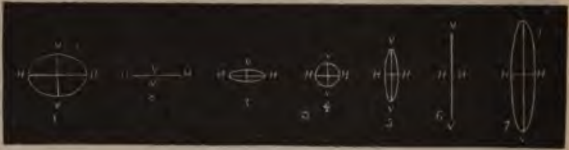
The cause of Regular As. lies for the most part in imperfect curvature of the cornea. The lens and ciliary muscle doubtless participate in the asymmetry, since they endeavor to counteract the imperfect refraction of the cornea by their dissimilar contractile and refractive powers. But for all practical purposes we may treat the defect as exclusively corneal. Most eyes are at least slightly As., the vertical meridian being usually more convex than the horizontal. But it is only when the amount of asymmetry becomes somewhat marked that the eye is called As. The cause of the ellipsoidal curvature of the cornea may be due to the pressure exerted by the eyelids, by the bending effects of the opposed recti muscles or the unopposed obliqui. As. may be hereditary, congenital or acquired.

FIG. 15.



Nature of Regular As.—It is plain, from the laws of refraction, that the more curved the boundary of the denser medium, the shorter becomes the focus of the transversing ray. It therefore follows that if this bounding surface be more curved in one meridian than it is in another, it will focalize rays striking it in this meridian, sooner than the rays of the less-curved meridian. It is so with the As. cornea, which has not inaptly been likened to the bowl of a spoon. The effect of such an unsymmetrical cornea upon a cone of light rays is shown in Fig. 15, in which V V are two vertical rays brought to a focus sooner than H H. If we suppose the retina placed at the intersecting lines from Nos. 1 to 7, the images formed will be those given in the geometrical forms of Fig. 16, whence it is apparent that rays from a round point are at no place brought to a point. The visual result is circles of diffusion and blurred outlines of objects. A glance at Fig. 15 will serve to elucidate the various forms of regular As. If the retina be supposed at the second line, it is obvious that for rays through the vertical meridian the eye is E., while for those of the horizontal meridian the focus is behind the retina. This variety is called, *Simple H. As.* If the retina be supposed at the sixth line, one set of rays focus upon it, while the other is in front, constituting *Simple M. As.* If both sets have their foci behind the retina it is called *Compound H. As.*, and if both are in front of the retina, *Compound M. As.* In *Mixed As.* one set is in front the other behind the retina. It is necessary to fix in the mind the fact of the two principal meridians being opposite each other and that the meridian of largest curvature is the one of longest focus; so that a horizontal line or object is more clearly seen if the vertical meridian be the more emmetropic one of the cornea, and *vice versâ*.

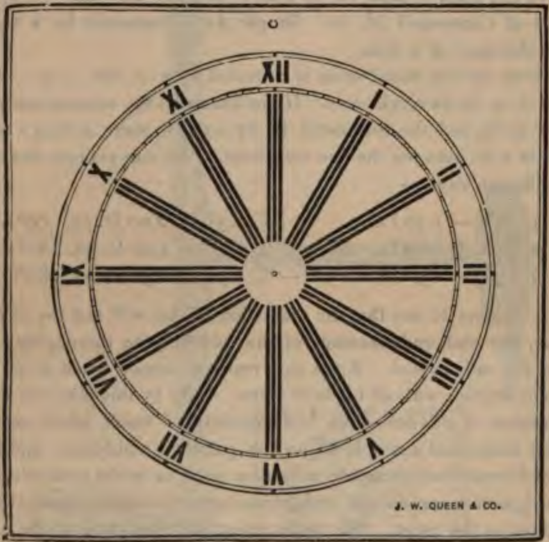
FIG. 16.



Symptoms.—As. is a fruitful source of asthenopia and headache, and such are the usual complaints first heard. These are produced by the endeavor of the accommodative apparatus to overcome the unequal refraction of the cornea by its opposed one-sided activity. There follows dimness of vision for distant objects, whose outlines become unequally blurred according to their position relatively to the more E. meridian of the eye. The patient may, therefore, tilt the head to see an object more clearly. In high degrees of As. the asymmetry of the cornea may be detected by the observer without any instrument.

Diagnosis.—An oval pupil with its long axis corresponding to the axis of As. may be often observed in high degrees of As. If with + or — Sph. lenses we are unable to bring a patient's vision to $\frac{20}{20}$, we at once suspect As., especially if no other causes of amblyopia are discoverable. If by the ophthalmoscope the outlines of some of the fine capillaries of the fundus are clear, while others require a different lens to bring them to the same degree of distinctness, As. is certainly present. We may in this way, with some approach to accuracy, measure the Am. of the different meridians by noting the lens which gives the clearest view of a fine vessel running in the horizontal direction; this will give the degree of Am. of the vertical meridian of the cornea. The lens which renders equally clear a capillary of the vertical direction gives the measure of the horizontal meridian of the cornea. The papilla of an As. eye appears oval viewed through the ophthalmoscope, the long axis corresponding with the meridian of greatest refraction.

FIG. 17.



For estimating As. with the test lenses a spectacle frame is required, with numbers from 0 to 180, beginning with the left side of either eye and extending around half the circle to the point opposite. The axes of astigmatic glasses are marked, and the number opposite the lens-mark indicates the meridian requiring no additional refraction. We need also a fan of radiating lines, or, better still, a Green's Astigmatic Card, shown in Fig. 17. When we have, by a sph. lens, got the greatest acuity of V. possible in this way, and it is yet below the normal, we then learn, by persistent question and direction of the patient's attention, if any of the lines across the clock face are more distinct than others. If those from III to IX are the clearer, we put over the sph. lens already in the frame cylindrical lenses, either plus or minus, at right angles to these lines, until we find one which brings out the lines of the opposite meridian as clearly. So long as certain of the clock-face lines are more distinctly seen than others, or the white interspaces narrowing to the centre are less sharply defined in some, so long is the As. not wholly corrected. When we have neutralized the As., we formulate the result in the patient's record, thus: O. D. V. $\frac{20}{70}$ Spb. + 1.50 D. ⊃ Cyl. + 0.50 D. ax. 90 = $\frac{20}{20}$, is an example of Compound H.As. O. D. V. $\frac{20}{100}$ Sph. — 2.00 D. ⊃ Cyl. — 1.00 D. ax. 180° = $\frac{20}{20}$, is an example of Compound M. As. Simple As. is corrected by a Cyl. lens, without the need of a Sph.

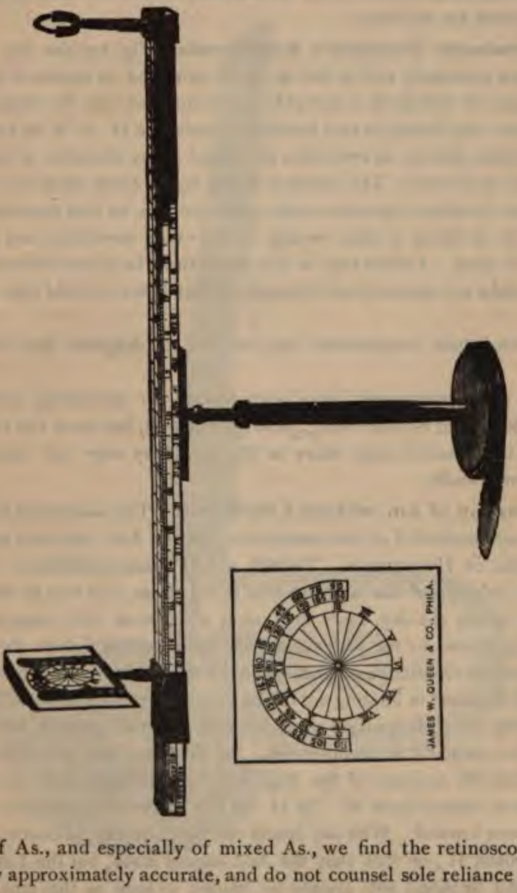
In mixed As. the visual error is corrected by a + Sph. ⊃ a — Cyl., or *vice versâ*, or by two cylinders. If, for example, the vertical meridian be M. by 1.50 D, and the horizontal H. by 0.50 D., there is thus a total difference of 2 D. between the two meridians. We can express this result in three different ways:—

1. Sph. — 1.50 D. ⊃ Cyl. + 2.00 D. ax. 90°—.
2. Sph. + 0.50 D. ⊃ Cyl. — 2.00 D. ax. 180°—.
3. Cyl. — 1.50 D. ax. 90° — ⊃ Cyl. + 0.50 D. ax. 180°—.

It is needless to say that the estimation of As. will test the physician's patience, tact and understanding of the subject quite thoroughly; experience is the only school. Rules and reading cannot teach it so well as persistent practice with all kinds of cases. Only by this plan can he reach that fineness of discrimination and certainty of result which make him sure that subnormal acuity is due to the patient's amblyopia, and not due to an undetected but corrigible refractive error, or to the patient's *intellectual* astigmatism or *mental* amblyopia—qualities which must always be considered in the count. We again repeat our conviction of the necessity of using a mydriatic, and especially in estimating As.

Other methods of Estimating As.—The application of **Retinoscopy** to the estimation of the As. error follows logically from the principles already set forth. Instead of the uniform change in all meridians of M. or H., we shall find in As. that a Sph. lens is at last reached that neutralizes the movement of the fundus reflex in one meridian alone, leaving the opposite meridian uncorrected. This is the indication that As. is present, and that we must now proceed with caution. The direction which the reflex takes shows also the axes of the As. We can now use Cyl. lenses, or perhaps the better plan is to note the Sph. lens required for neutralizing the movement in the more emmetropic meridian, and then proceed with the Sph. glasses till the opposite meridian is also neutralized. In low degrees of As., and especially of mixed As., we find the retinoscopic estimate only approximately accurate, and do not counsel sole reliance upon it.

FIG. 18



Tweedy's Optometer, Fig. 18, may be utilized to discover or confirm our estimate of As. The atropinized eye is made artificially myopic by a

+ Sph. lens, say of 5 D., placed in the clip, and a dial, holding a fan of fine lines is slowly brought from beyond the point of distinct vision. If the patient be As., of course some of the lines will become distinct before others. Noting the distance of the dial from the eye, we place — Cyl. lenses at right angles to the axis of the cleared lines, till those of the opposite meridian are as sharp.

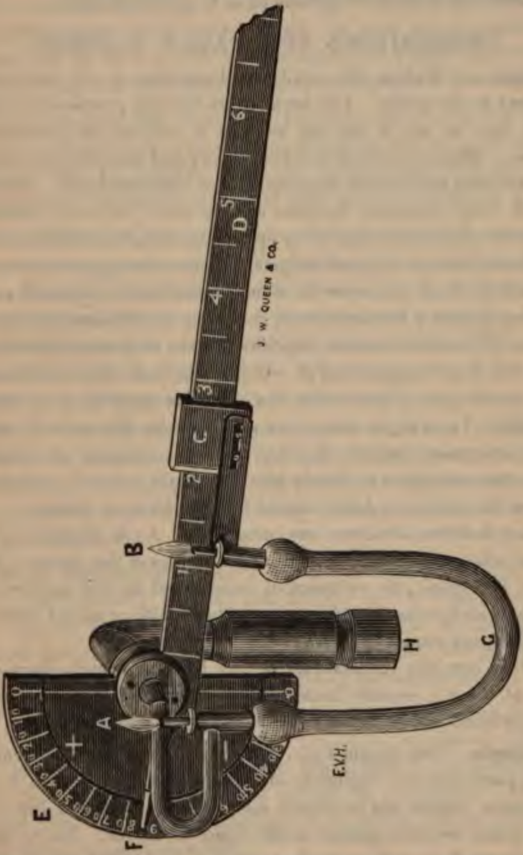
By **Professor Thomson's Ametrometer** (Fig. 19) the As. diffusion circles are measured, and so the As. itself estimated by means of two small flames, one of which, B, is movable and connected with the slide, C. An E. sees the two flames as two luminous points, the H. or M. as two homocentric disks, the As. as two disks elongated in the direction of one of the principal meridians. The distance of the lights apart when the disks are in contact, as shown upon the scale, gives the Am. of that meridian. The scale with its flame is then swung to the other meridians and estimates noted for each. Lenses can, at the same time, be placed before the eye till the disks are resolved into luminous points however little their distance apart.

This ingenious Ametrometer may be used to diagnose any other form of Am.

Many other instruments have been devised for measuring corneal As., that of Javal and Schiötz being, perhaps, the best, but since the crystalline (except in Aphakia) may share in the As., they may not always give satisfactory results.

Estimation of Am. without a Mydriatic.—The indications heretofore given have proceeded on the assumption that the Acc. has been suspended by Atropia or Homatropin. Though a half-dozen instillations of a two per cent. solution of the latter may be relied upon, and that its effects will pass off during the day, cases may occur when even this amount of time cannot be spared by the patient, or some other reason forbids its use. In these cases the Ophthalmoscope must be the chief reliance, and the surgeon's skill will be tested in hunting out the lurking or disguised errors. The dark room must have all daylight excluded and the wall present no object to arouse the patient's accommodation. In this way, and after considerable experience, the amount of the Am. may be estimated with approximate correctness, especially in M. In H. we can never be quite sure the total H. has been learned. With the distant test types we can, of course, discover the Manifest H., or that that the Acc. cannot mask, but the Latent (that neutralized by Acc.) will always be hidden so long as the lens has any elasticity. A method of getting the largest amount of the Manifest is to over-correct the H. by a strong + Sph. lens of, say 5 D., thus securing the greatest possible relaxation of the ciliary muscle. By successively neutralizing this with — Sph. lenses from weak to stronger, we finally reach one

Fig. 19.



that gives $\frac{20}{20}$ most perfectly, and the difference between the lenses is the measure of the Manifest H. This method approaches accuracy in proportion to the age of the patient, since with advancing age Latent H. gradually becomes Manifest, as is shown in Fig. 20.

But the possibility of As. is the hidden enemy we have always to fear in not using a Mydriatic, because low degrees are extremely difficult or impossible to unmask, and with sensitive, nervous people these are sufficient to produce the very troubles they come to us to get relief from.

PRESCRIBING SPECTACLE GLASSES.

Reliance on Rules, etc.—All our discussion, so far, has been only preparatory to this point. The intricate studies and practices of refraction are only data we are to use the moment of writing the prescription for spectacles. This is the focus in which theory and practice are to be united with an intimate and careful analysis of each individual case. Here, of all places, all blind obedience to rules will be fatal. If, as is perhaps true, three-fourths of the daily labor of an ophthalmic surgeon consist in refraction cases, the importance of good judgment is the more apparent, because the experience of others can never be of but limited use to one, each particular case being largely a law unto itself, requiring careful attention and study. Moreover, the immense natural difficulties of the subject are greatly heightened by the utter disagreement of writers as to their rules and recommendations, which goes to prove that few rules are possible to be laid down with safety. In trying to thread our way through this maze of contradictions and exceptions (which are often quite as numerous as proofs of the rule), we can only hope to briefly hint at certain rules of procedure that may serve the student as helps toward forming his own system.

We may, however, set down one certain rule: As. is always to be wholly corrected, whatever the age, history or peculiarities of the patient. Whether M., H. or Presbyopic, the existence of uncorrected As. can only be a source of weakness and ocular trouble which failing health or added years will be sure to bring out sooner or later.

Assuming that the refractive error has been accurately diagnosed, the location of the *p. r.* exactly found, let us see what are special conditions and circumstances to be borne in mind in prescribing for

Hyperopia.—Our patient's *p. r.* is beyond ∞, and he has to waste a less or larger portion of his amplitude of Acc. in first reducing the *p. r.* to ∞ before nearer objects can be clearly seen; he therefore has less Acc. left, and the strain becomes greater as the object is nearer. Just so far as his *p. r.* lies beyond ∞, just so far does his *p. p.* lie beyond the normal *p. p.* In other words, the range of Acc. does not differ whatever the refractive error. As a large rule, we endeavor to put the patient in that condition most nearly approaching the normal condition, and the first indication is, therefore, to bring the patient's *p. r.* to ∞. If, *e. g.*, we have found the H. to amount to 3 D., we desire to spare him the loss of his 3 D. of Acc. by a + Sph. 3 D. lens, which puts his *p. r.* at ∞. Whether we can do this in this and all other cases depends—

1. **On the degree of H.**—It is safer to give full correction of H. in proportion as the degree of the error is small. If there are no other contra-indications an H. of 1 or 2 D. may be nearly or wholly corrected. But when it is higher it is often found unsatisfactory to give the full correction.

2. **On the Age of the Patient.**—The older the muscles the less able they are to conform to the new order of things induced by a full correction, especially of high H., while in young and vigorous ones there is also a protest against being suddenly deprived of their habitual amount of activity.

3. **On the Clinical History of the Patient.**—If the H. is hereditary, or of a great many years' standing, the tissues will more reluctantly permit a sudden change in their stimuli and functional activity. If there has been a recent history of Asthenopia and frontal headache the sudden change of a full correction is apt to prove disastrous, and a notable reduction is advisable, according to the degree of H., and our judgment of the power of adaptation or rallying probable to be exercised by the patient.

4. **On the Avocation, Habits or Purposes for which Glasses are Desired.**—The habitual work and method of work must be considered. The musician or book-keeper wish the best acuity with the easiest Acc. at different distances from those required by literary people or those working at fine needlework, etc.

5. **On the Surplusage of Acc.**—In the young we have seen the range of Acc. to be relatively high, so that the *p. r.* can be placed at ∞ with greater impunity for the youthful H. than for the H. of middle age. Landolt thinks that the habitual and continued use of the ciliary muscle may consume two-thirds or at most three-fourths of the total power of Acc.

6. **On the Effects of + Sph. Lenses on Convergence.**—The connection between H. and convergence has been mentioned (see p. 33). Convex lenses, therefore, break in upon the normal or acquired relations between Acc. and convergence, and though the change be of the nature of a relief from the effort of convergence it should not be changed too suddenly or to too great an extent.

7. **On the Distance and Position of the Glasses Relative to the Eye.**—The further from the eye the glass is placed the greater its

power, if the eye be observing an object greater than double the focal distance of the glass, or vice versâ if less than double this distance. A high nasal bridge or ill-fitting spectacle-frame puts our test-lenses at a distance or at an angle which is different from the spectacles of the optician. These should be well centered, so that the visual axis pierces the lens centre for the most used degree of convergence. A + Sph. lens acts as a prism if, as commonly happens, the rays passing into the eye do so only through the edges of the glass, and the consequent displacement of objects is greater as the part of the lens looked through is nearer the periphery. The moral of all this is: Be yourself an optician, as well as watch your patient's optician.

8. On the Thoroughness of Atropinization.—The ciliary muscle is probably never wholly neutralized by atropia, and if we give the full correction of the glass the remnant ("*tone*") of its functional activity is added to that of the glass and produces an artificial myopia. The less certain we are of the atropine paralysis the safer it is to allow more largely for this so-called tone; one-fourth to one-half a D. is customary, with medium degrees of H.

These suggestions are, of course, in no way exhaustive, but point out only certain lines when circumspection is necessary. In glancing over them many considerations seem to resume themselves into a necessity of bridging over **the period of adaptation** which must ensue upon a more or less full correction; or we might call it a too sudden placing the *p. r.* from its abnormal position beyond ∞ to the E. position. *This is the ideal correction*, and anything short of it is not ideal success, and often, we may say, generally, comes from the unpleasantness and impatience both of the mind and the ocular tissues of the (often miscalled) patient, undergone during this **period of adaptation and transition.** In giving expression to the following method we have found highly successful in our practice, we would give a caution that it requires some bravery, and more knowledge of the patient, a knowledge that he will trust you and not expect perfect results at first. The plan we speak of is this: For the lower degrees of H., and, with small allowances, the medium degrees, where there are not strong contraindications, put the *p. r.* boldly at ∞, assuring the patient that the effects may not be perfect for the first weeks, but that the final outcome will be better, besides obviating the trouble of a change in glasses so soon. If we find asthenopic symptoms not relieved, or even increased, we prescribe Atropiæ Sulph. gr. $\frac{1}{100}$ ad. Aquæ ℥j dropped in the eyes once a day for some time, and by this means the transition period is passed with ease and happy results.

Myopia.—In addition to the conditions alluded to in reference to H., most of which holds good in M., we must not forget the minimizing effect of high degree — Sph. lenses. Hence the particular necessity of placing high numbers of M. glasses close to the eye. Even in the medium grades the patient must choose between clearness of outline and smallness of image on the one hand and blurred outlines of the image approaching the normal in size. An average is often made, or a compromise, for no lenses can unite the two very desirable things, and the degree of the compromise must be left to the taste of the patient. However high the M. a correcting glass above 8 or 10 D. will hardly ever be borne well. Two pairs of spectacles are advisable for M. of high numbers.

As a rule, Myopes bear full correction much better than Hyperopes, though at last each case demands individual study and attention. As in H., the weak Atropia solution helps often to break the suddenness of the change.

Should Spectacles be worn constantly?—If As. exists, and is properly corrected, we answer, yes; and the greater the degree, the more imperative it is to do so. This last holds good with the higher grades of M. and H. In the lower numbers more liberty of choice may be allowed. In simple M. of low grades eye-glasses may be prescribed which are removable at pleasure.

Anisometropia is that condition characterized by a difference in the refractive error of the two eyes. It very rarely happens, indeed, that the error is the same, but small variations are not practically considered.

There are **three varieties** of Anisometropia.

1. When there is synchronous fixation and binocular vision.
2. When there is alternation of fixation and vision.
3. When one eye alone takes part in vision.

It goes without saying, that the kinds of Am. in the two eyes are widely variable. As. may or may not be superadded to either monocular or binocular M. and H.

As the eyes are always refracted singly, the anisometropia appears at the completion of the tests; but in addition to the diagnosis of the separate refractive errors, it becomes, as regards treatment, highly necessary that we determine exactly to which of the three classes above mentioned the patient belongs.

Determination of the Class.—Fix the patient's gaze upon some object, and quickly interpose a prism horizontally before one eye; if the eye rotates toward the apex of the prism, binocular fixation is proved, and the anisometrope belongs to the first class. The refraction tests and their results will generally show if the case belongs to the second or third class. If both eyes have a nearly equal degree of acuity with their correcting lenses, they are probably used alternately, and, doubtless, without the knowledge of the patient, the eye most H. being used for distant objects, the other for near ones. By successively covering each eye, and at the same time testing each upon near and distant objects, we soon determine if alternate use still exists. Strabismus generally follows the setting aside of an eye, as in the third class of cases.

Treatment of Anisometropia.—It is only to patients of the first class that we seek to give stereoscopic or synchronous binocular vision, and even here it is not always successful. If the refractive difference is greater than 2 D., a partial correction of the more Am. eye is all that will generally be borne. The difference in the size of the retinal images is less easily borne than the diffusion circles of a partial correction. Caution, skill and judgment are here required of the physician—caution especially when it comes to any attempt at bettering the condition of those composing the second class. It is here very easy to make a bad matter worse. Stereoscopic vision is, as we have said, usually out of the question, and prudence requires little interference. Yet that little must be made, to keep the case from drifting into the third class. That is to say, we try to get the least useful eye to participate more in vision by a partial correction. The more hyperopic eye is, for most people, the one least used, and, unless excessive, its manifest H. will, at least, bear correction. The younger the patient, the more is to be hoped from the attempt.

As to the third class, two reasons urge us to endeavor to hold the unused eye to some functional activity.

1. That there may be vision, in case of accident to the better eye.

2. To avoid the disfigurement of the strabismus usually consequent upon non-use of an eye.

We should, consequently, advise exercise of the unused eye, preparatory to which an operation of tenotomy or advancement (*q. v.*) may be necessary and a partial correction of the refractive error.

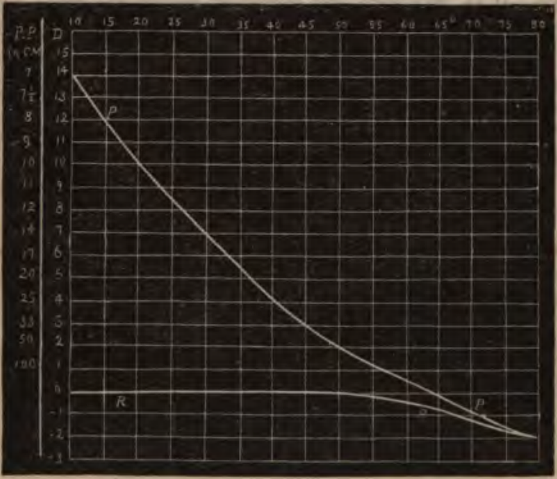
PRESBYOPIA.

Definition.—That condition of the eyes, occasioned by the lessened elasticity and consequent diminution of refractive power of the Lens, whereby the *p.p.* is removed beyond a point 8 inches away (216.5 *mm.*—Donders). More shortly, we may define it as the recession of the near point beyond an easy working distance.

Etiology.—The diminished elasticity of the lens is a change, as we see, from Fig. 20, that begins in youth, but which in E. eyes is not troublesome till it has progressed to such a point that our *p.p.* is no longer within the comfortable range of about 22 *cm.* The ultimate cause of the change is one with the general growth of the bodily tissues in solidification, atheromatous changes, etc.

Symptoms.—Dimness of V. for near work, asthenopia, etc., from its continuance, and necessity of holding the book or sewing at an increased and uncomfortable distance.

FIG. 20.



Degrees and Progress of Presbyopia.—Figure 20 (after Donders) gives a diagrammatic illustration of this condition. The age of the patient is given at the tops of the lines; the numbers of D. of Acc. corresponding to each age are shown at the side opposite the intersecting lines, with the position of the *p.p.* in a parallel column. The horizontal line starting at zero represents the emmetrope's refraction, the *p.r.*, and the fall of this line from 55, his increase of H (v, p. 34). From this we see that at about 45 years of age the *p.p.* has receded to 33 *cm.*, or 13 inches, a point at which continuous work becomes tiresome and difficult. The reduction of the range of Acc. is, of course, identical with the recession of the *p.p.*

Diagnosis.—Take the lens representing the focal distance of the point at which the patient desires or habitually works, and from this deduct the lens of the focal distance of the receded *p.p.* Thus, if the *p.p.* has reached a point twenty inches away, and we wish to bring it back to eight inches, we take the difference between + 2 D. and + 5 D. = + 3 D. as the proper correction. It is, however, always best to consult the patient's feelings and tastes by mounting the test lenses, and with Jaeger test letters, sewing, etc., learn which gives the most satisfactory result.

In every case of Presbyopia we must first test the patient for preëxisting M., H. or As. For this purpose no mydriatic is necessary, as a fairly accurate estimation can be made without. As before said, all As. must be corrected. If H. preëxisted, the presbyopic failure will make itself felt that much earlier, provided the H. has not been corrected by spectacles. If the patient has had H. spectacles, he may be surprised that they are no longer satisfactory. If not, the H. correction must be added to the presbyopic.

If the patient had previous M. uncorrected, the presbyopia will not become manifest till the increasing inelasticity of the lens has overtaken the M. Thus, if there be preëxisting M. of 2 D., the patient will not find himself needing glasses till he has passed 50.

Treatment.—Consists in prescribing the + Sph. lens that will replace the receded near point at a convenient working distance, somewhat variable according to the habit or occupation of the patient, generally about eight to twelve inches. Though we may thus tether the *p.p.*, we must not forget it is only for a time, and that in a few years it will be found to have strayed away, and stronger glasses will then be required.

The following are approximately the principal numbers for an E. deduced from the chart:—

Age.	*Acc. in D.*	*p.p. in inches.*	*Lens to reduce p.p. to 9 in.*
40	4	10	+ Sph. 0
45	3	13	1
50	2	20	2
55	1	30	3
60	0.50	80	4
65	0.25	∞	4.50
70	0.00	H.	5.50
75	0.00	H.	6.00
80	0.00	H.	7.00

PART II.

FUNCTIONAL DISORDERS AFFECTING VISION.

PARALYSES.

Paralysis of the Levator Palpebræ Superioris.—The result of this paresis is a falling and inability to elevate the upper lid, producing the condition called **Ptosis.**

Ptosis may be produced by other causes, chief of which are traumata, trachoma and redundancy of the skin, or flabbiness of the tissues. It may also be congenital. The greater portion of cases, however, are caused by paralysis.

Causes of Paralytic Ptosis.—I. *Peripheral,* as cold, rheumatism, orbital tumors or abscesses, exophthalmic goitre, etc., which produce pressure or inflammation of the nerves.

II. *Pressure at the Base of the Brain, e.g.,* syphilitic or rheumatic ostitis, periostitis, tumors, aneurisms, effusions and inflammatory exudations.

III. *Cerebral, e.g.,* softening, hyperæmia, sclerosis, tumors, aneurisms, effusions, etc.; implicating intellectual processes.

IV. *General Disease,* as syphilis.

Prognosis.—Favorable the more recent the attack, and also the more partial it is. Generally speaking, the prognosis depends on the cause. If due to cerebral lesion it is more doubtful.

Treatment.—According to the cause: when no other adequate cause can be found, suspect syphilis.

I. *Medical.*—When we have exhausted the probability of the affection yielding to drugs, hygiene, etc., we proceed to

II. *Electrical.*—If a daily use of the constant current (moderate strength —globe and mastoid process) give no improvement, we proceed to

III. *Surgical Operation.*

Paralysis of the Orbicularis—Lagophthalmus.—This condition is characterized by an inability to close the eyelids, the name being due to the staring appearance of the patient. Exposure of the globe to external irritants is followed by epiphora, conjunctivitis, keratitis, etc. The facial nerve is the one involved, and the paralysis may be special or general, partial or complete. Causes and treatment are the same as in ptosis from paralysis. The edges of the lids may be pared and united by stitches, to shield the eye from dust, etc., while the orbicularis is regaining its power.

Paralysis of the Ocular Muscles.—The seat of the lesion is relatively indicated by the number and kinds of the paralyses. The Internal, superior and inferior recti, the inferior oblique, levator palpebræ and sphincter of the pupil are all supplied by the third nerve; and if all these are paralyzed, we know the lesion must be intra-cranial; if only a part of these organs are affected, it is probably orbital. Double or binocular paralysis of the same muscles also points to a cerebral origin. Other paralyses are generally orbital.

Causes and Treatment are, in general, the same as for ptosis, already indicated.

Special Diagnoses.—The external rectus is supplied by the sixth nerve. An object moved outward past the median line is not fixed by the eye thus paralyzed, and *convergent squint* increases as the object is carried ostward.

Paralysis of the Superior Oblique, supplied by the fourth nerve, is detected by imperfect rotation downward and outward, causing diplopia and slight convergent squint.

Paralysis of the Third Nerve, if complete, is generally binocular, and results in ptosis and loss of all movements except outward by the external rectus and downward and outward by the superior oblique. There is mydriasis, no Acc. power and crossed diplopia.

If incomplete, as is more common, the phenomena are indicative of the parts affected. If of the internal rectus alone, there will be the same inability to preserve fixation as an object is moved *inward* past the median line, that was noted of the outward movement when the external rectus was spoken of. The diagnosis is also not difficult in the cases of the paresis of the superior and inferior recti and the inferior oblique. Paralysis of the sphincter of the pupils—**Iridoplegia**—produces moderate mydriasis and insensitiveness to light of the pupil.

Paralysis of the ciliary muscle alone—**Cycloplegia**—to be distinguished from presbyopia, produces loss of Acc. power, easily diagnosed. Iridoplegia combined with cycloplegia is called ophthalmoplegia interna, as the paralysis of the external muscles is called ophthalmoplegia externa.

Treatment, as before, consists in seeking out the causes; when electricity —both by the constant and the interrupted currents—combined with constitutional remedies, fails to give relief, tenotomy, or tenotomy with advancement (*q. v.*), may be advised.

Paralysis of the Dilator Pupillæ, supplied by the cervical sympathetic, causes **myosis,** but this last may also be due to spastic action. The **"Argyll-Robertson pupil,"** a valuable diagnostic sign of incipient locomotor ataxia, has the peculiarity of responding to Acc. but not to light. The reflex action is lost, but the associated movement remains perfect.

Paralysis of the Retina.—This may be complete or partial. Cases of the former are excessively rare, and show the lesion to be in front of the chiasm. When partial, there is usually a division of the field of vision into two nearly symmetrical halves. There have been a few cases where the paralysis was of the upper or lower half, *i.e.*, where the dividing line was horizontal, but it is almost always vertical. The condition is called

Hemianopia, or, more improperly, Hemiopia. With slight irregularities and few exceptions, the vertical line cuts through near the macula, dividing the fields of both eyes into two parts. It results that the affected or blind halves may be

1. Homonymous, *i.e.*, both right or both left sides—most commonly the right.
2. The two nasal, or the two temporal sides. (Very rare.)

Causes.—The lesion (hemorrhage, tumor, etc.) is cerebral and behind the chiasm or optic commissure. Into the vexed question of the location of the lesion we cannot enter here, though it is quite generally admitted that it may be in the occipital lobe and angular gyrus (the ultimate coördinating centre) or in the opposite optic tract.

Diagnosis.—The ophthalmoscope will show no indication. The patient's symptoms are clear, and by fixing his gaze upon a point, we can roughly determine the blind parts of the fields by motions of the fingers at different angles, the eye not under examination being covered. More exact determination should be made with the perimeter. (See p. 63.) Retinal hemorrhage, or retinal detachment are quickly distinguished from paralytic hemianopia by the ophthalmoscope, as this will reveal the characteristic lesions.

Prognosis depends on the nature of the intra-cranial lesion, whether it be caused by an embolism, tumor, apoplexy, periostitis, or of traumatic origin. Syphilis is to be borne in mind.

Treatment is to be wholly constitutional, and directed to combating the origins of the trouble.

SPASMS.

Spasm of the Orbicularis is called **Nictitation** in the lighter form, when there is slight involuntary twitching of the lids, or **Blepharospasm** in the more severe cases, when they are convulsively pressed together. We have had several cases where the muscular movements extended themselves to the face, and one where the arms and hands sympathized, simulating a well-marked and typical case of Chorea. Proper spectacles completely cured the affection, showing that a refractive error may produce misleading and unexpected symptoms. Other causes are local irritations which set up reflex neuroses.

Treatment.--Be on guard against hysteria. If the cause cannot be found, and the case fails to yield to constitutional and local applications, we must look to the refraction; division of the supra-orbital nerve is a last resort.

Spasms of the Ocular Muscles are rare except in the disease called **Nystagmus**, which is characterized by spasmodic oscillations of the eye-ball in any direction, but generally laterally. It is usually congenital, and commonly associated with amblyopia. Beyond attention to the general health, and the correction of refractive errors (which may serve as cause or aggravation) treatment seems unavailing.

Spasm of the Ciliary Muscle, or of Acc. has been already alluded to, and often gives the surgeon a deal of trouble. We may discover it by the ophthalmoscope, the granular look of the Choroid-epithelium changing in clearness as we look at it, should the spasmodic action of the muscle chance to take place. The test consists in a marked difference between the *p.r.*, as evidenced by the patient's reading of the distant letters (without atropia) and the refractive error as shown by careful ophthalmoscopic examination. The first will simulate a high degree of M., which can only be unmasked and the exact estimation of the degree of spasm made with precision by thorough atropinization.

The Causes of spasm of Acc. are usually the strain or prolonged use of Am. eyes without correcting spectacles. It may accompany M. and As. but is more commonly found in young Hypermetropes. It may be due to insufficiency of the internal recti.

The Treatment consists in complete atropinization, continued till the spasms yield. This may require atropine instillations for a week, though generally not so long. Proper glasses should then be prescribed and the transition or adaptation period (see p. 48) carefully watched, while the irritation may be stilled by the use of a weak mydriatic, F. 14, once a day, as recommended. If due to weak internal recti muscles, prisms, base in, may serve a good purpose.

Spasm of the Sphincter Pupillæ.—Myosis from spasm of the sphincter is generally an associated movement coexisting with spasm of the Acc.

MUSCULAR INCOÖRDINATION—STRABISMUS.

Definition.—That condition of the eyes in which the visual axes do not both converge upon and transfix the object.

Causes.—The over-action, under-action or paralysis of a muscle or of a set of muscles. The association of convergent strabismus with H. and divergent strabismus with M. has already been set forth.

Varieties.—I. Paralytic, which has already been alluded to. II. Concomitant, having full range of movement.

The term **Apparent Strabismus** is used to denote a certain appearance of the eyes simulating real strabismus, and is caused by a large angle alpha (the angle formed by the visual and optic axes) in H. which makes an apparent divergence, or in M. a negative alpha angle may give rise to a seeming convergence of the visual axes. This is tested by alternately covering the eyes while fixing an object and noting if there be deviation upon uncovering the suspected eye. A better and more certain means is to test the power of the internal and external recti muscles with prisms. In normal eyes abduction varies from 4° to 6° and adduction from 12° to 20°. Therefore abduction of more than 6° and adduction of less than 10° or 12° give intimations of abnormalism. The object should be twenty feet away.

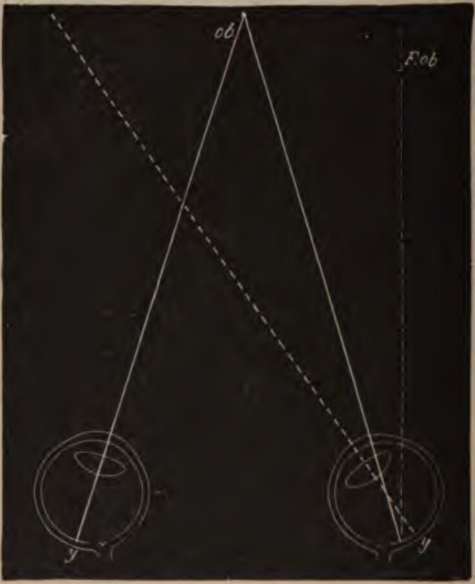
Concomitant Strabismus may be

Unilateral, when the same eye always deviates;
Alternating, when either eye fixes;
Constant, when the condition is a permanent one;
Periodic, when recurring at intervals or irregularly;
Convergent, when the squinting eye is turned to the nasal side;
Divergent, when the squinting eye is turned to the temporal side.

Symptoms—Diplopia.—The patient complains of seeing double. Binocular vision, as we know, is possible only when the two images are formed on identical parts of the retinæ. If one image be thrown aside there will be a false image formed in a direction opposite to that of the deviation of the eye. When the Strabismus is convergent the diplopia is *Homonymous;* when divergent it is *Crossed.* This will be rendered more clear by Fig. 21, where the image of the object *o b*, is thrown on a retinal point of the convergent eye accustomed to receive images from the same side or from the right (*F. o b.*) while in Fig. 22 the false image is by the divergence thrown on a point of the retina as if coming from the left or crossed side.

The less the squint the more troublesome it is, because the false image is clearer. In extreme cases no false image may be formed and so no diplopia exists.

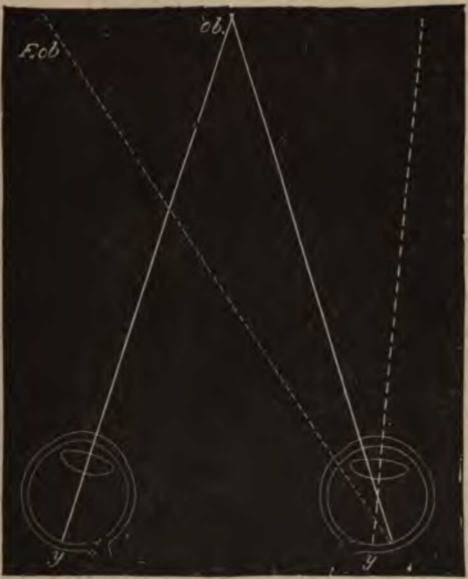
FIG. 21.



Diagnosis.—If the distance between the images remains uniform while the eyes (with rigid head) follow an object moved across the field of vision, it is evident the strabismus is not from paralysis. The deviation of the squinting eye when the normal eye fixes, is called the *Primary Deviation;* that of the normal eye while the affected eye fixes, is called *Secondary Deviation*. The position of the false image is readily determined, and so the nature of the diplopia or squint deduced, by alternately covering each eye. *The amount* depends on the angle of the strabismus, which, of course, depends on the distance apart of the two images in relation to the distance from the eye. The perimeter and a distant object beyond it may be utilized for its accurate measurement.

Treatment.—In the young a correction of the refractive error serves quite often to correct the strabismus, because the squinting eye has been, perhaps, turned aside to get rid of its more imperfect image, or has not been kept to its work, because of the uselessness of its service. If the patient be too young to wear spectacles, exercise of the deviating eye is to be advised till spectacles can be worn. After a probationary period with the spectacles of a few weeks or even months, without improvement, a tenotomy, or tenotomy with advancement of the opposite tendon, must be done. In adults the surgical operation may be at once advised when the degree of deviation is considerable. In all cases the proper spectacles must be worn constantly after tenotomy.

FIG. 22.



ASTHENOPIA.

Definition.—Fatigue of the ocular muscles or visual powers.

Causes.—Uncorrected Am. producing strain of the muscles; too prolonged use of the eyes; anæmia, etc.

Varieties.—I. Accommodative, affecting the ciliary muscle, generally due to H.

II. Muscular, due to weakness or strain of the internal recti, commonly caused by M.

III. Retinal.

Symptoms.—Inability to continue near work; dimness of vision; headache; lachrymation; heaviness of the lids; fatigue.

Diagnosis.—For practical purposes of treatment it is not necessary to distinguish between the varieties. The refractive error will point them out. If no such error exists we may think of hysteria, unless a decided anæmia is sufficient to explain the case.

Treatment.—The refractive error is to be corrected by proper glasses. If the symptoms do not yield we prescribe F. No. 14. Rest for asthenopic eyes is always advisable.

AMBLYOPIA.

Synonyms.—Anæsthesia optica; amaurosis is sometimes used to denote blindness, and sometimes as interchangeable with amblyopia. Being thus indefinite and unnecessary it is advisable to discard it.

Definition.—That disturbance or subnormal acuity of vision which is due neither to dioptric abnormalism nor to visible organic lesions. "The patient sees nothing, neither does the physician." In a strictly verbal sense, this definition would include those cases we have called retinal paralyses, but the distinction is clear enough, as a more or less easily recognized cerebral lesion underlies these.

Varieties.—I. *Amblyopia Congenita*, or congenital lack of acuity. The lower degrees may be binocular, but the higher are generally monocular and connected with H. or As. Often associated with strabismus and nystagmus.

II. *Amblyopia Exanopsia*, or, from disuse of the eye. It is monocular, and generally connected with anisometropia and strabismus. It is a disputed point whether the strabismus is caused by the amblyopia, or *vice versâ*.

III. *Tobacco and Alcohol Amblyopia* is characterized especially by a subnormal acuity of the central field, while the periphery preserves its usual strength. This is particularly true for red color, and sometimes for green. The ophthalmoscope reveals no decisive indications. Either tobacco or alcohol produce this condition after long use. The patient's symptoms are, of course, imperfect vision, "mist," and other local troubles. The progress is toward atrophy, which, in time, may become apparent by the ophthalmoscope. Other poisonous substances, as in lead poisoning, uræmia, diabetes, etc., may induce much the same conditions and symptoms. Quinine is particularly to be noted in this connection.

IV. *Traumatic.* Blows upon the skull or globe of the eye, even spinal concussion, may induce temporary, or even permanent, amblyopia. Rigid myosis may follow such injuries. Fissure of the roof of the orbit, hemorrhage into the optic sheath, pressure on the optic nerve, or even globe, of the eye, from other causes, are often the immediately preceding conditions.

V. *Hysterical and Feigned Amblyopia.* Hysterical amblyopia is not uncommon, but malingering is more often found in countries where conscription exists, or in military life.

VI. *Nyctalopia,** or night blindness, is an early symptom of Retinitis pigmentosa, but may also be superinduced by long exposure to bright light, sleeping with the face exposed to light, as the moon, etc.; snow or ice blindness is the same phenomenon. Hemeralopia, or day blindness, the reverse of this condition, is rarely met with.

VII. *Amblyopia from various Entoptic Phenomena.*

- *a.* *Muscæ volitantes* are rings, snake-like forms, or dots, which swim before the eyes, and are more common in M. They are either the shadows of the retinal vessels, or of remains of vitreous cells floating before the retina.
- *b.* Micropsia, in which things seem too small, is supposed to be due to a dispersion or pressing apart of the retinal elements, so that fewer receive the image.
- *c.* Megalopsia, the opposite of the last-named condition.
- *d.* Metamorphopsia, distortion, produced by unequal changes of the retinal elements.

Diagnosis.—It will thus be seen that the term Amblyopia is used as a name for lessened acuity where no cause has been determinable, or perhaps, even sought for. When we have proved the defect to be due to any of the preceding classes, it is because all refractive errors and visible organic lesions have been shown to be excluded. The patient's history and symptoms will generally put us on the track of a satisfactory diagnosis, though much tact and skill is often necessary to unravel the sometimes subtle indications.

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* The signification of the term seems to be philologically correct as we give it above. The exact reverse has, until lately, been the meaning adopted. The words are, therefore, apt to give rise to confusion, and, perhaps, should be abandoned.

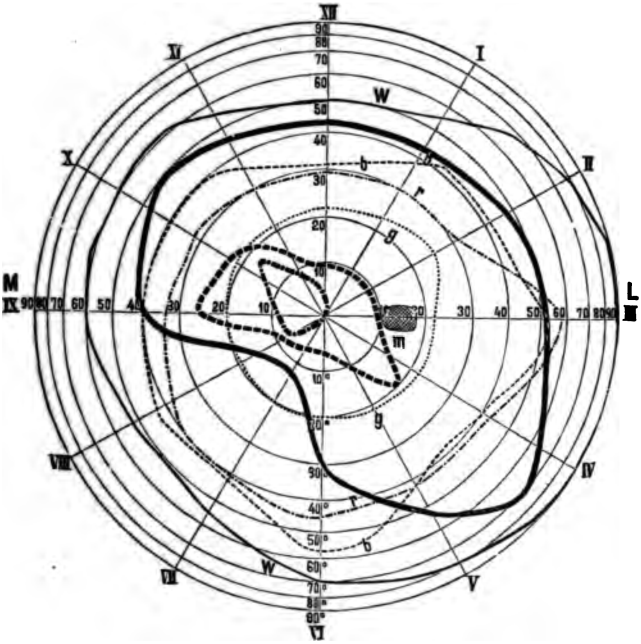
Treatment will, of course, depend upon the diagnosis and the ultimate causes. Smokers and drinkers may continue their excesses only at their imminent peril. If they will abstain, strychnia may aid in the restoration of vision. In all cases the correction of any refractive errors is advisable, though these may not be directly responsible for the condition. For nyctalopia, rest and smoked glasses are demanded. In all these cases the constant current (five to ten cells) has been found to be beneficial in many cases. *Little can* be done for the relief of the entoptic phenomena mentioned.

FIG. 23.

DIMINUTION OF THE FIELD OF VISION.

This is a condition accompanying several well-marked pathological conditions, and peculiarly symptomatic of them. These are, particularly, retinitis pigmentosa, glaucoma, detachment of the retina, hemianopia, etc., under which heads details will be given later. But the phenomenon may exist in cases where no assignable disease is plainly discernible, and notably in cases of color blindness, so that it may be properly described as an amblyopic affection.

FIG. 24.



The Color Field is with the same or ordinary degree of illumination more restricted than the field for achromatic light, blue and yellow having nearly the same extent as white, while red and green lie within. With sufficient strength of illumination the extreme peripheral portion of the field perceives colors perfectly, thus showing the defect to be due to lack of exercise.

Diagnosis may be roughly made by covering one eye and fixing the patient's gaze upon your own, and moving the hand or a light from the centre outward upon all four sides till it is no longer visible. A yardstick may also be used, but for accurate determination a perimeter is necessary. Of these instruments there are many in the market. Probably McHardy's self-registering is the most convenient. This is shown in Fig. 23. When the traveler, *i*, is just within the visible field, the chart is pressed against the pointer, *p*, which moves concentrically with the traveler and so perforates the chart at a meridian corresponding to the degree of the angle of the object. The chart of the normal vision for achromatic light and colors is given in Fig. 24.

Normal Limits of Perception.—

	White.	*Blue.*	*Red.*	*Green.*
Externally	70°–88°	65°	60°	40°
Internally	50°–60°	60°	50°	40°
Upward	45°–55°	45°	40°	30°–35°
Downward	65°–70°	60°	50°	35°

Treatment.—Where limitation of the field is the result of organic lesions, the treatment must depend upon what these are, as will be further considered under glaucoma, etc. In case anæmia and no assignable cause can be given, electrical treatment may be tried.

COLOR BLINDNESS.

This condition, formerly called Daltonism (and sometimes named achromatopsia or dyschromatopsia), has, of late, acquired much attention, and deservedly so, because of the vast practical importance it has in relation to the signals by which railway trains and vessels are moved. A signal-man, pilot, engineer, etc., who cannot distinguish differences in the colors of the signals plainly jeopardizes the lives of travelers; and yet it is found that about four per cent. of men are deficient in color perception. Women are rarely so. It is obligatory on all transportation companies that use colored signals to test their employés as to their color perceptions.

The condition of color blindness is generally hereditary, and seems to have no pathological significance or causes. No remedies are proposed for it; no cause but disuse is assigned for it. We are wholly ignorant of any lesion, retinal or cerebral, preceding its appearance. The retinal cones are doubtless the intermediates of color sensation but no color-blind retina seems to have been secured for microscopical examination.

Varieties.—It is found that defective color perception usually appears as affecting red and green, blue and yellow, or very rarely, all colors; but where perception of red is wanting, green is also, and vice versâ; the same of blue and yellow, though there is no such sharp and absolute distinctions in any case as the hobby-riding color theorist sometimes avers. It is impossible to say exactly what the sensations of a color-blind person are. He probably sees different colors as various degrees of illumination, or intensities of one color, and in this way he is enabled to distinguish quite minute differences, just as we perceive one color, white, through many grays, to complete blackness. All degrees of deficiency and partial "blindness" are found. With these modifications borne well in mind we may accept, at least provisionally, the following divisions:—

1. Red-green blindness.
2. Blue-yellow blindness.
3. Total color blindness.

Diagnosis.—There are many plans of testing the color-defective sense, based upon revolving disks, colored-glass, or paper, *etc.*, but Holmgren's colored yarns are generally admitted to give the easiest and most satisfactory means of diagnosis. A confused mixture of colored skeins of wool are laid before the patient, and three test colors, skeins colored light green, rose or purple, and red, are given him; he is then to select the same or similar colors from the heap. Merely naming the colors will not do, because many a man with perfect color-sense could not properly name many or any colors. Prof. Thomson has arranged the wools in a system, and in such a manner that the testing can be carried on by one who is not an expert, and his ingenious method also enables a record of the numbers of the mismatched skeins to be kept for report or comparison, both of which are advantages perfectly evident.

Most color and visual tests are practiced with perfect illumination and at short range; but it may be doubted if many eyes are not defective just to the degree that they would prove themselves normal under these advantageous circumstances but would be found wholly incapable of proper distinctions with the imperfect illumination *generally* present and at the distance *always* existing, in land and water-signaling.

Treatment is wholly prophylactic. There can be little doubt that defective color vision is a result of non-exercise of the color-sense. Quakers are notably deficient in acuity of color perception, and women are rarely color blind. Nocturnal animals are devoid of cones, while some birds have two Foveæ. The young should be exercised in color vision, and provision for such gymnastics be a part of all school discipline. We are indebted to color for much of the utility, and, one may say, most of the pleasure, of life.

HYPERÆSTHESIA OF THE RETINA.

This condition is chiefly characterized by extreme sensitiveness to light. Lachrymation, and spasmodic activity of the lids may also accompany it. It occurs principally in the super-sensitive and hysterical. The photophobia is sometimes carried to such a ridiculous degree that hysteria is evident. If ophthalmoscopic examination be permitted no departure from the normal can be detected. Errors of refraction may lie at the root of the trouble, but if not, the case resolves itself into one of that numerous and growing class of the hyper- and pseudo-cultivated hothouse plants which is at once the physician's bane and amusement. Formulæ 37 and 38.

PART III.

DISEASES OF THE EYE.

SPECIAL DISEASES—DISEASES OF THE LIDS.

BLEPHARITIS.

Synonyms.—Blepharitis Marginalis; Ophthalmia Tarsi; Tinea Tarsi; Sycosis Tarsi; Blepharo-Adenitis; Blepharitis Ciliaris.

Definition.—Inflammation and œdema of the border of the lids.

Causes.—I. Sequelæ of Conjunctivitis, Keratitis, *etc.*; II. Uncorrected Am.; III. Inflammation and Degeneration of the roots of the cilia; IV. Idiopathic, or as consequence of strumous diathesis.

Symptoms.—Swollen and angry lid edges, accompanied by itching and soreness; a gummy exudation sticks the lids together during sleep, or dries in scales or crusts along the edges. In extreme cases the lashes may fall out (Lippitudo).

Prognosis.—Very favorable.

Treatment.—If the incrustations are not easily removable by the hand soften them with F. 22, and remove also with the epilation forceps those cilia which are plainly diseased. Order F. 20 or 21, once, twice or thrice daily, carefully applied along the borders. If a refractive error exists, the blepharitis, as well as other disorders, may be its result, and not subside till proper spectacles are prescribed.

Sequelæ.—In severe and chronic cases may produce distichiasis, trichiasis, even entropion or ectropion, and by closing the puncta, also result in epiphora and diseases of the lachrymal duct.

HORDEOLUM (STYE).

Definition.—A furuncular or phlegmonous inflammation located near the hair follicles of the margin of the lid.

Causes.—Constitutional derangements, uncorrected Am., exposure to cold, etc., or the diseased root of cilia.

Treatment.—Besides the general preventive measures relatin
general health and correction of refractive errors, which are espe

able, as these troublesome visitors come "in crops," special means are found in astringent and antiphlogistic lotions, as F. 6. If the offending lash is seen, pluck it out. Poulticing may give relief and aid the stye to point, when it may be opened.

CHALAZION.

Synonyms.—Meibomian cyst, tarsal cyst, tarsal tumor.

Definition.—A small tumor arising from the inflammation or closing of the duct of a meibomian gland.

Character.—It is generally about the size of a small pea, points, usually, toward the palpebral conjunctiva, producing irritation and considerable discomfort.

Diagnosis.—Eversion of the lid shows a pinkish or dusky patch over the swelling, though the latter may not always be pronounced enough to notice.

Treatment.—Remove. (*See Operations.*) F. 2, or 4.

ENTROPION.

Definition.—Inversion of the eyelid against the globe.

Causes.—I. Result of the cicatrizations following trachoma; II. Consequent upon blepharitis; III. From traumatic origin, burns, etc. IV. Blepharospasm.

Varieties.—I. Distichiasis, a double row or excessive number of cilia; II. Trichiasis, the eyelashes only inverted; III. The lid itself turned in—entropion proper.

Treatment.—Epilation should be repeatedly tried for distichiasis and trichiasis before trying the surgical operations. (*See Operations.*)

ECTROPION.

Definition.—Eversion and conjunctival exposure of the lid.

Causes.—I. Relaxation of the tissues, as in old people; II. Cicatricial changes consequent upon injuries, burns, etc.; III. Sequelæ of conjunctivitis, blepharitis, etc.

Treatment.—In the mildest forms, styptic lotions, *e.g.*, F. 1, or 3, and measures to reduce the conjunctivitis, may succeed in giving greater tone to the flabby parts. If not, surgical operation must be advised. (*See Operations.*) For severe forms nothing else suffices.

Sequelæ.—An almost invariable result of ectropion is eversion of the puncta, and consequent epiphora and conjunctival irritation and hyperæmia. For this condition, slitting the canaliculi may give relief. (*See Operations.*)

MISCELLANEOUS AFFECTIONS OF THE LIDS.

Xanthelasma are yellowish patches, perhaps slightly elevating the skin, and situated beneath it. They are objectionable only from a cosmetic point of view. They may be cut out with scissors, if desired.

Horny and wart-like formations are prone to grow from the lids, and should be removed.

Rodent Ulcers are the more frequent of carcinoma of the lids. They should be wholly removed.

Syphilitic Ulcers and Gummata upon the eyelids are the same in character and treatment as upon other parts of the body.

Molluscum Contagiosum, Naevi, Fibroma, etc., may also occur upon the lids.

Crab Lice (pediculus pubes) may find a lodging on the lashes.

DISEASES OF THE LACHRYMAL APPARATUS.

DACRYO-ADENITIS.

Causes.—Inflammation of the lachrymal gland, of rare occurrence, arises from sympathetic irritation from neighboring tissues, from traumatic origin, from cold, compression, etc.

Characteristics.—Usually, a chronic swelling, which may be mistaken for a tumor, or *vice versâ*, in the upper and outer margin of the orbit. It is generally painless and not tender to the touch, though in acute stages may be excessively so.

Treatment.—The usual antiphlogistic remedies may be tried. Free incisions, to allow escape of pus, if suppuration threatens, are to be recommended. The danger of an obstinate fistula should be borne in mind. In chronic hypertrophy, or inflammation of the gland, its excision may have to be decided upon.

EPIPHORA.

Definition.—Overflow of tears upon the cheek.

Causes and Varieties:—

I. From excessive secretion, caused by inflammation of the gland, or from the reflex action of neighboring irritations.

II. From eversion of the puncta in ectropion.
III. From obstruction of the puncta or canaliculi.
IV. From obstruction or stricture of the sac or duct.

The Puncta and Canaliculi may be closed or clogged by lodgment of foreign bodies or the products of inflammatory exudations, by the cicatricial tissue following trachoma, or wounds, by the œdema of blepharitis, etc.

Treatment.—Slit up the canaliculus. (*See Operations.*)

DACRYO-CYSTITIS.

Synonyms.—Mucocele; Blennorrhœa; Swelling of the Lachrymal Sac.

Definition.—A phlegmonous inflammation of the lachrymal sac.

Causes.—This disease is preceded by a period of œdema and irritation, caused by obstruction and constriction of the sac or duct, and may be noticeable only by its effect in producing epiphora. If not relieved, a tumor becomes perceptible in the neighborhood of the sac, which, upon pressure, throws up its contents, colorless or pus-like, according to the length of time the breaking down has been going on.

Various causes may produce the constriction; catarrhal inflammation, injuries to the nasal bones, periostitis, etc.

The adjacent tissues of nose and cheek may take up the inflammatory processes in a way to deceive one in the diagnosis, and cause intense pain and trouble to the patient.

Treatment.—The lower canaliculus must be slit up and the duct opened with a probe. (*See Operations.*)

The probe should be passed at intervals of every one, two or three days, according to necessity, for several weeks. When the duct shows a persistent determination to close up, a style will have to be worn for a longer or shorter period, till this habit is overcome.

Sequelæ.—There is usually **conjunctivitis**, by extension of the inflammation, and possibly **blepharitis**. When the dacryo-cystitis has produced **abscess of the sac**, free exit should be given the pus by slitting the canaliculus, and external puncture. So soon as the condition of the tisssue will permit, the duct should be probed, and an injection of an astringent and soothing character used (F. 1), by means of a syringe. The abscess should be speedily healed, to avoid the danger of a permanent **fistula.**

DISEASES OF THE CONJUNCTIVA.

PALPEBRAL CONJUNCTIVITIS.

Synonyms.—Simple Conjunctivitis; Hyperæmia of the Conjunctiva.

Definition.—Inflammation and congestion of the capillaries of the palpebral folds of the conjunctiva.

Causes.—I. Long continuance of near work and strain of the ocular muscles; II. Uncorrected errors of refraction; III. Exposure to colds, winds, etc.; IV. Dust or foreign bodies.

Symptoms.—The patient complains of a gritty feeling, as if sand were in the eye, smarting and itching.

Diagnosis.—Upon everting the lids, the injected capillaries are seen; there may be some hyperæmia. We must make a thorough examination, as foreign bodies lodged in the folds create quite the same subjective symptoms.

Prognosis.—Unless of very long standing, it will yield to treatment in a few days, or, at most, weeks.

Treatment.—F. No. 1 is especially recommended *t. d.*, though Nos. 2, 3, or 4 are good, and to be used for a change or under special circumstances.

MUCO-PURULENT CONJUNCTIVITIS.

Synonyms.—Simple Conjunctivitis; Conjunctivitis; Catarrhal Ophthalmia; Catarrhal Conjunctivitis.

Definition.—A contagious inflammation of the conjunctiva, accompanied by a muco-purulent discharge.

Causes.—The various causes producing palpebral conjunctivitis may, it seems, also bring about this more severe one. Chronic palpebral conjunctivitis may also degenerate into this. But the chief cause is, doubtless, contagion. Caution about the use of towels, etc., must always be urged upon parents and those afflicted.

Symptoms.—The palpebral folds are hyperæmic, the capillaries injected; the lids are stuck together in the morning by the drying of the discharge. In severer cases, the ocular conjunctiva participates in the congestion.

Diagnosis.—In severe forms, it passes, by insensible gradations, into purulent conjunctivitis, from which, as well as from the palpebral form, it seems to be distinguishable largely, perhaps only, in degree.

The **differential diagnosis** becomes important:—

I. **Cyclitis** is characterized by a deep-seated, circumcorneal zone of inflammation, connected with an extremely exalted sensibility and tenderness to touch. The congested vessels do not move with the conjunctiva.

II. In **Iritis** the seat of the inflammation is, likewise, sub-conjunctival, over which the ocular conjunctiva can be moved. The pupil is sluggish, the iris muddy or dulled in color.

III. In **Episcleritis** the seat of inflamed vessels is between the sclerotic proper and the conjunctiva, and is not an uniform zone or ring, but generally attacks a part only of the tissues at one time, usually starting opposite the palpebral fissure within or without, and traveling slowly about the cornea.

IV. In **Keratitis** the transparency of the cornea is reduced and the circumcorneal zone of inflammation is seen to be of the nature of an extension from the corneal trouble.

Thus, though conjunctivitis of any kind may be complicated with these deeper-seated affections, the chief cause may be generally easily fixed upon. In all conjunctivitis the inflamed tissue is seen to move over the other tissues, by the drawing of the lid back and forth.

Prognosis.—In the less severe forms the disease is self-limited, running its course in about two weeks. The most severe cases will generally recover in a longer time without treatment, though chronic and settled cases are by no means rare. Under treatment it may be aborted if taken early enough, or, as a rule, cured without great difficulty at any stage.

Treatment.—Extreme cleanliness; predisposing causes, as refractive errors, ectropion, trichiasis, obstruction to the excretion of tears, *etc.*, to be removed; F. 22, or 20, applied along the edges of the lids at night, to prevent them from becoming glued together; F. 4, and also 12, is especially advisable, or F. 7 and 5 may be used.

PURULENT CONJUNCTIVITIS.

Synonyms.—Purulent Ophthalmia; Conjunctival Blennorrhœa; Contagious, Military or Egyptian Ophthalmia; Ophthalmia Neonatorum, Diphtheritic and Gonorrheal Ophthalmia.

Definition.—A conjunctival inflammation with purulent discharge, distinguished from muco-purulent conjunctivitis particularly as a more severe and highly contagious form.

Causes.—Chiefly induced by contagion, the rapidity with which it spreads having erroneously led some to ascribe to the air a power of transporting the noxious germs. Carried to another eye matter from a mild form of muco-purulent conjunctivitis may set up this severer inflammation. The induced disease begins in from one to four days after infection. Micrococci are found in gonorrheal pus.

Symptoms.—Those of the muco-purulent variety intensified in every way. The cornea may become affected and the lids swollen, painful upon pressure; the implication of the cornea is the great danger to be feared, which tends to ulcerate, from lack of its nutrition, through chemosis of the adjacent parts.

Varieties.—I. Gonorrheal Ophthalmia, caused by infection of urethral discharge by the hand, towel, handkerchief, *etc.*; II. Ophthalmia Neonatorum, from the mother's purulent discharge reaching the eyes during parturition. The last is not so severe as the gonorrheal class in the adult, but is remarkable as causing more blindness than any other single cause. III. Diphtheritic Ophthalmia.

Treatment of Gonorrheal Ophthalmia.—I. Absolute cleanliness is the primal and constant necessity. This includes protection of the healthy eye by a Buller's shield or such certain means that it shall not become infected by the secretions of the diseased one. The purulent matter should be removed, carefully everting the lids, by means of syringe irrigations and by a camel's-hair brush or a soft bit of moistened lint; this should be done every one or two hours, day and night, so long as the discharge continues. II. The inflammation and œdema are to be reduced by leeches to the temples, incisions of the lids, ice or cold compresses over the eyes and neighboring tissues. In washing out the folds of the palpebral conjunctivæ an astringent and antiseptic lotion should be used (F. 10). The palpebral portion of the conjunctiva, after the early stages of the disease have passed, should be touched once daily with a mitigated solid silver nitrate stick (F. 33), or when the discharge has stopped, with an alum crayon, (F. 32). If F. 29 be preferred, the eye must be washed with warm water immediately afterward. The corneal indications are to be watched, and if caustics do not relieve, or if they increase the cloudiness of that tissue, they must at once be dropped; occasional insufflations of levigated calomel may aid in excretion of discharges. It is well to anoint the lids with a simple ointment, like F. 22, once or twice daily. When the chemosis and discharge have lessened or ceased, granular formations similar to trachoma commonly appear on the inner surfaces, and are to be treated exactly as trachoma (*q. v.*). Protective bandages to insure rest are necessary, and occasional weak atropine instillations are advisable. Mr. Burnham, late Senior House Surgeon at Moorfields, London, successfully treated these cases with a one in twenty solution of carbolic acid, very frequently applied to the palpebral conjunctiva.

The prophylactic part of the treatment is too often neglected; physicians treating syphilitic patients should warn them of the ocular danger.

Treatment of Ophthalmia Neonatorum, is the same in principle as that for the adult disease, but must be adapted to the circumstances and conditions. The disease generally appears about the third day after birth, and is usually binocular; if not it will be difficult, but not impossible, to protect the healthy eye by a light cotton compress strapped securely. Lid retractors are to be used in raising the lids, whose folds must be washed out and cleansed with F. 8, every hour until the discharge is lessened.* Instead of the stick of mitigated silver nitrate, F. 28 is advised, once daily. Leeches, scarification and ice-bags are out of the question, and the inflammation is to be reduced by warm poppy fomentations and other general antiphlogistic measures. Prophylactic measures should be a part of all lying-in practice.

Diphtheritic or Croupous Conjunctivitis.—This type of purulent Ophthalmia differs from the others in no essential particular, but is characterized by the fact of the discharge forming a membranous layer in patches or all over the palpebral conjunctiva, which bleeds easily upon removal of the membrane. The treatment differs but little from that given; greater care, if possible, being used in regard to caustics. The danger to the cornea is great. F. 11 is the best, in our experience.

Sequelæ of Purulent Ophthalmia.—Of these, corneal ulcer and perforation are the tragical results if the case be not seen early enough, or if the treatment be not successful. This brings with it prolapse of the iris, anterior synechia, anterior staphyloma, and probably hopeless blindness. When this complication threatens, a weak solution of atropia, F. 13, *note*, should be dropped in the eye after each dressing, to prevent iritic adhesions, and every exertion be put forth to reduce the impediments to corneal nutrition. When perforation is probable, care must be used in everting the lids, *etc.*, and to lessen the intraocular tension, paracentesis of the anterior chamber (*see Operations*) may be deemed advisable.

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* The nurse holds the child with its head placed upon the physician's knees.

TRACHOMA.

Synonyms.—Granular Ophthalmia; Granular Lids; Follicular Conjunctivitis; Granular Conjunctivitis.

Definition.—Inflammation of the palpebral conjunctiva, characterized by increased thickening and vascularity, and the formation of neoplastic granular elevations, or lymphoid infiltrations.

Causes.—Ill-nutrition, fatigue, bad ventilation, etc., may produce the affection spontaneously, but the greater number of cases arise from infection. May follow purulent ophthalmia.

Symptoms and Diagnosis.—Externally, œdema and vascularity of the lids is noticeable, while the ocular conjunctiva is congested and angry; photophobia and lachrymation, "gritty" feeling, are present in proportion to the roughening of the palpebral conjunctivæ. Upon everting the lids we find, in the early stages, the surface covered with miliary granules, presenting an appearance as of tiny boiled sago grains, scattered or massed together. This must not be mistaken for the hyperæmia of the papillæ consequent upon palpebral or muco-purulent conjunctivitis. In the chronic type these vesicular formations are crowded together, and, becoming partially absorbed, produce tendinous scars and dense thickenings of the conjunctival and sub-conjunctival tissues. In all cases this roughening of surfaces greatly irritates the folds and ocular surfaces, and may produce, by mere friction, a host of resultant troubles.

Treatment is directed to reduction and absorption of the granular formations, best brought about by such astringents, frequently applied, as will hasten this process without injuring the conjunctiva. A mistake is too often made by using too strong caustics or astringents. The treatment requires much time and frequent applications. In the less malignant types, alum crayon applied to the everted lids daily is the principal indication. In more obstinate or chronic cases, F. 25 or 31, delicately touched upon the granular surfaces, followed by irrigation, will serve to cut short the growths. Resort to nitrate of silver is not to be advised except in extremely malignant and obstinate cases. We have sometimes been able to hasten the cure by eversion of the lid and excising the granules with scissors. Perfect rest is demanded. It is needless to emphasize the constant need of extreme cleanliness, as well as attention to constitutional treatment and hygiene.

SEQUELÆ OF TRACHOMA—PANNUS.

The troublesome sequelæ of trachoma are all natural consequences of the friction of the roughened palpebral conjunctivæ, requiring, for the most part, only a removal of the cause to bring about their disappearance. In certain cases this is not so. The cicatrices following the absorption of the granulations may so "pucker" the conjunctiva as to draw the lid edge inward, producing trichiasis or entropion, and a harsher friction than from the trachoma directly. The most frequent and troublesome result of trachoma-friction is called

Pannus.—Though this condition is a corneal affection, synonymous with vascular keratitis, it is almost always found to be solely the result of trachoma, and so to be classed here. It is characterized by a sub-epithelial infiltration of cells and distended capillaries from the limbus conjunctivæ, forming a fine and tortuous meshwork toward the centre of the cornea.

Treatment.—With the restoration to the normal of the conjunctiva and lids, pannus generally disappears at once; when it does not, peritomy (*see Operations*) is advised, and is usually successful. When this fails to relieve the corneal irritation and cloudiness, an artificial purulent ophthalmia, produced by Jequirity (F. 39), has sometimes succeeded in relief. The eyes are bathed with the infusion for one or two days, *t. d.*, till a moderately severe inflammation is superinduced, which may be allowed to run its natural course; if successful, the cornea should clear up within two weeks. The advantages of this treatment are certainly doubtful, but it is infinitely preferable to the pernicious practice which had formerly a certain vogue, of infecting the eye with the discharge of ophthalmia neonatorum.

PHLYCTENULAR CONJUNCTIVITIS.

Synonyms.—Scrofulous, Strumous or Pustular Conjunctivitis.

Definition.—Inflammation of the ocular conjunctiva, characterized by phlyctenulæ at the corneal margin, and sometimes by a congested vascular meshwork, counterfeiting pterygium, extending toward the cornea. The cornea is generally somewhat implicated, the disease being dangerous in proportion.

Causes.—The strumous are most subject to it; generally occurring in the young, anæmic, or ill-fed.

Treatment.—F. 24, a small bit in each eye, once daily, alternated or followed by insufflation of levigated calomel with weak atropine drops (F. 13, *Note*), generally succeed in bringing about relief. Protective bandage should be worn, for the sake of rest.

PTERYGIUM

Is a vascular thickening of the ocular conjunctiva, probably caused by dust irritation, extending in a triangular form from the inner or outer canthus toward the cornea, over which it may grow till the apex reach the pupillary space. If not progressive, it may be interfered with only for cosmetic reasons. If there is danger of extension upon the cornea, the operation of transplantation should be undertaken. Simple excision is not advised. The operation of transplantation consists simply in dissecting the pterygium away from the cornea and conjunctiva up to its base. The lower flap of the conjunctiva is then dissected away from the globe sufficient to form a pocket, into which the pterygium is twisted and folded, and fastened by a suture or two. The cut conjunctival edges are then brought together, and the pterygium allowed to shrivel and atrophy.

Xerophthalmos or Xerosis is a dry, shriveled and lustreless condition of the conjunctiva, for which soothing lotions, F. 1–3, palliative and restful treatment, are indicated. Apply F. **22** at night, along edges of lids.

Pinguecula.—A small, yellowish dot of sub-conjunctival tissue thickening; has no pathological significance. May be excised.

Lupus, tumors, epitheliomata and sarcomata, may arise in the conjunctival tissues.

DISEASES OF THE CORNEA.

PHLYCTENULAR KERATITIS.

Synonyms.—Vesicular or Pustular Keratitis (or Corneitis); Herpes Corneæ.

Definition.—A superficial inflammation of the cornea, characterized by the formation of small vesicles, generally about the sclero-corneal margin.

Causes.—Failure in corneal nutrition; usually occurs in the strumous type, in underfed children, etc. It commonly coexists with or is consequent upon phlyctenular conjunctivitis, with which it is closely allied in character and treatment.

Symptoms.—As in all affections of the cornea, the photophobia is the controlling symptom. Children will bury their heads in the nurse's dress or hide in dark places. Lachrymation is, of course, also excessive.

Treatment.—The general health must be reached and improved by proper nourishment, exercise, etc. With improvement in this respect, the phlyctenulæ will soon disappear under F. 13, thrice daily. Bathe the eyes freely, irrigating the surface of the globe with F. 1–3, and touch the lid edges at night with F. 23, alternating with F. 24. Warm salt baths should be given three or four times weekly.

Sequelæ.—Ulcers of the cornea, unless checked in season.

INTERSTITIAL KERATITIS.

Synonyms.—Diffuse, Strumous, Parenchymatous, Syphilitic Keratitis (or Corneitis).

Definition.—A diffuse, non-suppurating affection of the whole cornea, characterized by cloudy or opalescent opacity.

Causes.—It is estimated that over 50 % of the cases are due to inherited syphilis, which is also shown in the features, teeth and general constitution. It occurs mostly in the young, and more frequently in girls than boys; the general nutrition is at fault.

Symptoms.—The "steaminess" or "ground-glass" opacity begins at the margin, accompanied by slight vascular injection of the adjacent capillaries. The whole cornea becomes affected by degrees. Corneal vascularization may or may not follow. Blepharospasm, photophobia and lachrymation are quite certain concomitants.

Prognosis will depend, in great measure, upon the possibility of proper and persistent treatment. The duration of the disease under treatment is a matter of months, or even years. The general health must be looked after sharply. Some imperfection of vision, due to imperfect transparency of the cornea, will, at the best, probably remain. Youth justifies a more favorable prognosis.

Treatment.—The more plainly marked the specific origin, the more advisable becomes the mercurial treatment, F. 36. In lighter cases, iodide of iron, cod-liver oil, etc., should be given persistently. The local treatment consists in F. 13, dropped in the eyes at least once daily, as a sedative and preventive of iritic adhesions. F. 5–23 should be used after the acuter stage has passed. Peritomy is advisable if vascularization (Pannus) of the cornea has proceeded far. Food and hygiene are extremely important matters.

Sequelæ and Complications.—Iritis, and even irido-cyclitis, are apt to supervene. Nebulæ of the cornea clear up slowly or not at all.

SUPPURATIVE KERATITIS.

Synonyms.—Abscess of the Cornea; Ulcus Corneæ Serpens; Hypopyon-Keratitis.

Definition.—A process of suppuration in the corneal substance, with or without inflammation, leading to abscess and ulceration.

Causes.—As a result or complication of inflammatory lesions of adjacent tissues, from corneal innutrition, from trauma, etc. Those of a strumous diathesis are particularly subject to it.

Varieties.—I. The Inflammatory, characterized by the coexistence of inflammatory symptoms; II. The Indolent, or Non-inflammatory, in which the corneal substance tends to break down and slough without acute symptoms. Either variety may be circumscribed or diffuse.

Symptoms.—Intense photophobia and lachrymation always accompany the inflammatory type, while the indolent variety may be entirely free from these symptoms.

Diagnosis, etc.—The diffuse yellowish cast appearing during corneal inflammation is the proof of infiltration and formation of pus. If the breaking down of the lamellæ do not concentrate itself at any circumscribed spot, there is a general weakening of the whole substance, until intraocular pressure produces a staphylomatous bulging forward, in addition to the opacity already existing.

When a point or patch of suppuration is differentiated, we have abscess, which may break into a superficial ulcer, or may empty itself backward into the anterior chamber—possibly, even both at once—forming a fistulous opening.

Treatment.—When inflammatory symptoms are present, atropine, F. 13, should be dropped in the eyes freely several times daily, both for its soothing effect and for the purpose of preventing iritic adhesions. Astringent and antiseptic irrigation is advisable. The eyes should be tightly bandaged, to insure rest. Hot fomentations are sparingly useful, and F. 7, combined with F. 25, once a day. The indolent ulcer must be aroused by stimulants to a certain inflammatory activity. More persistent warm fomentations, firm pressure bandages, and at last a restricted use of F. 34, with calomel insufflations. Antiseptic dressings should be used in all cases, and it is needless to speak of the general health.

SEQUELÆ OF SUPPURATIVE KERATITIS.

Hypopyon is an accumulation of pus in the anterior chamber. It is sometimes hard to distinguish from **onyx**, a collection of pus between the corneal lamellæ. By oblique illumination we can generally locate the deposit. It may be tapped by an incision at the corneo-scleral margin, if it do not disappear with abatement of suppuration.

Corneal Ulcers, whether deep or superficial, generally require no operative treatment in addition to the indications given above. If perforation threaten, paracentesis is to be done at once, and relief from severe pain may be gained in the same way.

A peculiarly obstinate and troublesome form of ulcer is what has been called **serpiginous ulcer**, or Saemisch's ulcer. It has a curved or waving margin, a gray floor, and, unlike most other forms, shows a constant tendency to extend itself over the surface of the cornea. Other complications, as iritis, are apt to occur, and hypopyon is almost always present. Cicatrization of the edge opposite its extending portion is common. Perforation is more liable to occur in this form. It generally arises from traumatic origin. It is, probably, a fungoid growth. In addition to treatment already indicated, antiseptic dressings are more requisite. Saemisch's operation was to divide the ulcer just beyond its growing edge, through the healthy tissue, the cicatrice arresting its growth. The evacuation of the hypopyon and aqueous at the same time lessened pressure. The wound is kept open for some days. The galvano-cautery is also used for the same object and in a like manner.

Staphyloma of the Cornea is produced by a perforating ulcer. Its only treatment is by operation (*q. v.*).

Corneal Opacities.—If these are not uniform and diffused over the whole cornea, great help may be found to vision by making an artificial pupil. If dilatation of the pupil give better vision, the clearer portion indicates the direction of the proposed iridectomy. Slight or cloudy opacities are called **Nebulæ.** **Maculæ** are more pronounced and easily recognizable, while **Leucomata** are intense white spots transmitting no light, and of unpleasant appearance. In nebulæ following recent ulcers of the cornea in children, an ointment, composed of gtt. xx–xxx of the oil of turpentine to ℥j of vaseline, has often proved beneficial in our practice. Leucomata are removed by tattooing (*see Operations*).

Anterior Synechia, or adhesion of the iris to the cornea, may be a product of perforation, whereby the iris gets lodged in the opening.

SUNDRY CORNEAL DISORDERS.

Keratitis Punctata is characterized by the formation of opaque dots on the posterior surface of Descemet's membrane, consequent upon inflammation of adjacent tissues. These are distinguishable from the spots of pigment or lymph left by iritic adhesions after synechia.

Arcus Senilis is caused by fatty degeneration immediately within the border, and often forming a complete ring. It is a senile change without pathological significance, and offers no obstacle to cicatrization, for example, after cataract operation.

Conical Cornea (Keratoconus) is a cone-like bulging forward of the cornea, caused by the intraocular pressure upon the weakened or thinned tissue. There may be a slight nebula at the apex of the cone. Its diagnosis is not evident in slight degrees, and the resultant imperfection of vision not corrigible by Sph. or Cyl. lenses may lead to a supposition of amblyopia. Lenses seldom help vision any, and the operations advised are only partially successful at best. (*See Operations.*)

Tumors, epithelioma and sarcoma of the cornea sometimes occur.

DISEASES OF THE SCLEROTIC.

EPISCLRERITIS AND SCLERITIS.

These inflammations are of much the same character, the former being the more superficial, affecting the sub conjunctival and external sclerotic tissues. They may exist separately or combined. **Episcleritis** is characterized by a reddish hyperæmia of the episcleral tissue, of circumscribed area, showing generally a tendency to slow movement about the front of the ball. It is of doubtful origin, more frequent in women, and obstinate to treatment, with liability to recurrence. Scleritis, or sclerotitis, is a deep-seated, purplish patch of inflammation, which may extend to wider areas, and which is also intractable and of long duration.

Treatment.—If the strumous diathesis is present, or syphilitic causes, the internal treatment is indicated thereby. Locally, atropine instillations, protection, rest; caustics are contraindicated. Massage has been advocated. The frequent occurrence of these troubles, especially episcleritis, in mothers nursing their babies, leads to indications as to general nutrition and hygiene.

Corneal infiltration with inflammations of the uveal tract are apt to follow chronic scleritis, and scleral staphylomata may occur from the weakening of its fibres. When the cornea is at all extensively implicated, the prognosis is much more unfavorable. The Heurteloup leech applied to the temple, abstracting six to ten ounces of blood, will relieve pain and cut short the progress of the disease.

DISEASES OF THE IRIS AND CILIARY BODY.

IRITIS.

Causes.—Inflammation of the iris may result from a number of causes. The rheumatic or the gouty are peculiarly liable to be attacked, and syphilis is the origin of a large proportion of cases. Exposure to cold and trauma are also frequent precedents, while the extension of inflammation from adjacent tissues may be its origin.

Varieties.—I. Plastic, including such types as syphilitic, rheumatic, etc., and characterized by the exudation of gelatinous or plastic material. II. Serous, from the nature of the fluid excreted by the iris. III. Suppurative (or parenchymatous), showing a swollen and nodular condition, due to the formation of inflammatory products in its tissues.

Symptoms and Diagnosis.—A medium degree of lachrymation and photophobia is generally noticeable, and sometimes frontal headaches and pains about the eyes are most marked, while at others, especially in the serous form of the affection, no pain is present. Owing to the exudative material thrown out, the aqueous is apt to become cloudy and lessen visual acuity. The color of the iris is altered in varying degrees, often assuming a dusky, rusty or muddy tinge. The sluggishness, and even immobility, of the pupil is always a certain diagnostic sign. Nodular formations are symptomatic of secondary or tertiary syphilis, but it must be remembered that syphilitic iritis does not always present itself in this way. Indeed, there is no certain sign by which the source of the iritis can be certainly named. The patient's history must, therefore, be carefully elicited in order to reach the probable origin of the inflammation. There is usually a fatal proneness to extension of the inflammation to surrounding tissues.

Prognosis.—With care and proper treatment, and if seen early enough, the prognosis is favorable, though certain defects of vision, due to adherent pigment or exudation spots, will remain, if already formed. The duration of the attack is from a few days to several weeks.

Treatment.—If under 40 years of age, immediate instillation of atropine drops (F. 13) is imperative. If the patient be over 40 the drug, if used at all, must be with the greatest caution. This drug exercises a many-sided beneficial effect: Primal is the necessity of preventing adhesions of the iris to the lens—**Posterior Synechia**—or of breaking them up, if already formed. It sets the sphincter, and hence the body of the iris, at rest, while also alleviating, to some extent, the pain. If adhesions have already formed, persistent and oft-repeated instillations must be made, until they are seen to be useless. If atropine produce irritative symptoms ("atropine poisoning"), as it occasionally does, F. 16 must be used; and if increased intraocular tension follow its use, it must be discontinued instantly. If tension continue or increase, paracentesis is advisable. The eyes should be lightly bandaged in severe cases and absolute rest secured. Beyond the use of atropine, no local treatment is usually required except the customary antiphlogistic measures, if there be hyperæmia or œdema, in which case 6 to 8 leeches to the temples are suggested. An iridectomy is only advisable in the most obstinate cases and when other means have failed. The great danger of producing glaucoma in the old forbids any but the most prudent and minimal use of atropia; so it is well that the disease is for the most part confined to young and middle-aged adults. If the gouty, rheumatic or strumous diathesis be present, the proper constitutional remedies must be persistently given, and if a history of syphilis is elicited, the general poison must be proceeded against after the usual manner. Mercury and the iodides are, indeed, beneficial in any iritis, especially plastic and suppurative.

Sequelæ of Iritis.—The pupil is often irregular, because of the posterior adhesions; but if these adhesions, under atropine, do not give way except unequally, the pupillary edge may present the appearance of a looped curtain. If the edges remain uniformly attached, it is called **Exclusion of the Pupil.** If the lymph thrown into the aqueous form in a kind of membrane occupying the pupillary space, we have **Occlusion of the Pupil.** Sometimes the iris becomes attached or caught in wounds of the cornea and **Anterior Synechia** is the result. This rarely happens except in injuries. In excluded or occluded pupil there is a tendency to an increase of fluid in the posterior chamber, which will bulge the iris forward, and may proceed so far in interfering with the excretion of fluids as to set up secondary glaucoma. Spots upon the lens capsule are apt to remain after recovery, when there has been anterior synechia. **Hypopyon** may be produced by iritis. **Cataract** from proliferation of the lens capsule epithelium often happens in chronic irido-cyclitis.

CYCLITIS.

Definition.—Inflammation of the ciliary body.

Causes.—Most generally from injuries, but also by continuity of tissue from iritis, choroiditis, etc., and from sympathetic ophthalmia.

Varieties.—Plastic, Serous and Suppurative, having no special diagnostic signs, and all treated alike.

Symptoms and Diagnosis.—A deep-seated circumcorneal ring of injection; the congested vessels do not move with the conjunctiva; excessive tenderness; the aqueous and vitreous will be found to contain excretion products, and are sometimes so turbid as to interfere with vision and ophthalmoscopic examination. Hypopyon may exist, and severe ciliary neuralgia is not infrequently connected with these symptoms.

Cyclitis rarely exists without iritic complication—irido-cyclitis—and the choroid also usually participates.

Prognosis.—If taken in its inception or early progress, it can be usually arrested; but if not combated thus early, or if it do not yield readily to treatment, serious results are prone to occur. A penetrating wound (*see Injuries*) is especially dangerous. Great cloudiness of the humors, due to large amounts of exudative material, is apt to be followed by glaucoma, disorganization of the vitreous, and sympathetic ophthalmia, of which last the earliest signs must be watched for with extreme vigilance.

When the process of atrophy or shrinking of the globe begins, enucleation is to be urged.

Treatment.—Same as for iritis. Warm fomentations or leeches to the temple help to empty the engorged vessels.

See, in this connection, *Sympathetic Ophthalmitis*, *Injuries*, *Enucleation*.

DISEASES OF THE CHOROID.

CHOROIDITIS.

Causes.—Inflammation of the choroid is most frequently caused by syphilis, inherited or acquired. Distention of the tissues by posterior staphyloma often gives rise to a local or more extended choroiditis. The disease is noticed most frequently among those of a strumous diathesis. The ultimate causes of very many cases are at present impossible to make out. Injuries and wounds are the most common causes of suppurative choroiditis.

Varieties.—Serous, Plastic or Disseminated, and Suppurative—with many subdivisions—and Sclerectasia Posterior.

Symptoms and Diagnosis.—I. *Serous Choroiditis* presents no marked objective symptoms except, perhaps, a diffuse cloudiness of the vitreous and slight floating opacities. The intraocular tension is increased, and may be mistaken for glaucoma, to which it may lead. The ophthalmoscope shows no lesion of the fundus oculi.

II. *Plastic or Disseminated Choroiditis*—usually binocular—is in its incipiency hardly distinguishable by the ophthalmoscope from the normal fundus.*

The only means of diagnosticating this type of choroiditis is by the ophthalmoscope. There are many varieties: Choroiditis disseminata simplex; Choroiditis areolaris; Chorio-retinitis centralis, or circumscripta; Syphilitic, *etc.*

Round, grayish-white spots of exudation mark the inception of the disease. Atrophic changes ensue, by which the sclerotic becomes visible as white patches surrounded by a girdle of black pigment. No *certain* sign indicates the lesion as due to syphilis, though small circumscribed posterior patches, with little tendency to grow and coalesce, and surrounded by a faint reddish zone, are pointed out as particularly symptomatic. The variety called *Areolaris* is confined to the posterior pole of the eye; the others usually begin at the periphery.

That the choroid is the primary seat of the lesion is shown by the fact that the retinal vessels can be traced *over* the spots of atrophy without change. Rarely the pigment epithelium atrophies as a whole, and the chorio-capillaris is plainly exposed. Opacities and cloudiness of the vitreous may ensue. *Scotomata* are results most certain to follow from retinal injury and participation in the inflammatory changes, and these are troublesome, as they are more central. Micropsia and metamorphopsia show, if present, the retinal changes. If the choroiditis be peripheral and extensive, a contraction of the field will follow.

III. *Suppurative Choroiditis*, unlike the other forms, makes itself known by all the signs of acute and rapid general inflammation in the external visible tissues. The exudative material thrown out between the choroid and retina, viewed by the ophthalmoscope, gives us the convincing diagnostic sign: a golden-yellowish reflex. The vitreous and iris particularly are implicated, and in the malignant forms all the ocular tissues are rapidly drawn into the fatal progress, the condition of *panophthalmitis*. It is needless to say that the patient suffers intensely.

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* It is, of course, supposed that the student has, by much practice, made himself familiar with the appearance of the normal fundus. No description can help him much and the finest chromo-lithographic plates can only give him useful hints. The **color of the fundus** is formed by the meshwork of capillaries of the choroid and the pigment layers of the choroid and retina. The retina itself is wholly invisible. The retinal vessels and the disc are the striking features, standing out from the light or brownish-red glow of the illuminated background. In light-haired persons this fundus-glow is much brighter than in brunettes, in whom it is sometimes so brown as to render illumination very imperfect. The choroidal vessels are plainly seen in blondes, while the pigment epithelium of the retina, showing like a delicate stippling, is the finest object to fix upon. Sometimes in dark people the pigment lies in folds or ripples, which may lead the novice to consider it pathological.

IV. Under *Myopia* we have alluded to the fact of choroiditis accompanying the formation of posterior staphylomata, either as cause or effect. This form of choroiditis is called sclerotico-choroiditis posterior, or sclerectasia posterior, and usually is present in high degrees of M. and always in progressive M. The "M. crescent" increases the area of the "blind spot." If inflammatory symptoms follow, the progressiveness of the atrophic changes of the choroid is certain. The connection of glaucomatous symptoms with the stationary (non-inflammatory) type of posterior staphylomata, shows that the recession of the posterior pole of the eye works as a preventive of glaucoma, a fact not often enough remembered, perhaps.

Prognosis must be very guarded, and is, on the whole, unfavorable. There is more probability of arresting the progress of the serous type. In the disseminated, one can, at best, only hope to retain a part of the vision left, while the suppurative variety marches on irresistibly to a fatal conclusion. Those afflicted with a large staphyloma posticum are in constant danger of its increase, of choroidal inflammation being induced, or of glaucomatous symptoms.

Treatment.—If there be a history of syphilis, clear or suspected, the indications should be sharply followed up, and even in all cases a "mixed treatment" will not be amiss, as tending to hasten the absorption of the inflammatory products. If anæmia or other constitutional weakness show itself the system should be supported by firm tonic treatment. As to local treatment it will be often only palliative. The use of atropine, except where iritis coexists, is not advisable, because of its tendency to produce increase of tension, one of the great hazards of choroiditis. If congestion of the vessels and external tissues be evident, warm fomentations, and antiphlogistic measures are urgent. Whenever there is a marked rise of intraocular pressure a speedy iridectomy, or at least, a paracentesis of the anterior chamber, should be done. Pain may have to be relieved by the temporary expedient of morphine hypodermatically injected. Leeches may be deemed advisable. Absolute rest and immobility of the eye are demanded in critical stages; stooping postures to be avoided in all. Justifiable hope is often past while we still hope, and enucleation is frequently advisable before proceeded with.

DISEASES OF THE CRYSTALLINE LENS.

CATARACT.

Definition.—Opacity of the lens or of its capsule.

Causes.—Renal disease has been supposed to be the cause of idiopathic cataract, but it is more probable, though only a theory so far, that atheromatous degeneration of the carotid, diminishing the nutrition of the eye, is thus early felt by the lens, producing calcareous and fatty deposits and other senile changes. Traumata are frequently the cause of cataracts.

Varieties.—I. Congenital; II. Acquired (result of general or local disease); III. Traumatic; IV. Senile. Subdivisions of these classes we shall consider in detail.

Cataracts may, of course, be simple or complicated; they may be stationary or progressive; they may be soft or hard. The most important distinction refers to their maturity or "ripeness," whence they are classed as unripe, ripe, or over-ripe (Morgagnian).

Symptoms.—Disturbance of vision and reduction of acuity according to the kind of cataract and its maturity. If the opacity begins at the centre, bright light which contracts the pupil lessens visual power. "Fogginess" and "spots" will be complained of.

Diagnosis, etc.—I. Congenital cataract may be complete or partial. If complete and there be an otherwise healthy eye, with an ability to tell light from darkness, the operation of *Discission* should be advised. If incomplete it is well to test the possible advantage of a preliminary iridectomy, since, if no improvement result, this will be of use in subsequent extraction of the lens, and if vision is better thereby, it spares the patient the double infliction of heavy spectacles and loss of accommodation.

Zonular, or Lamellar Cataract is either congenital or arises idiopathically within a few months after birth, though often not discovered till in youth. In this variety a zone of opacity, supposed to be produced by a temporary interruption of nutrition during formation of the lens, lies between a transparent centre and periphery. The patient may be considered myopic, and the cataractous shell fail to be discovered except upon dilatation of the pupil. It is usually stationary. If vision is not greatly improved by dilatation of the pupil there can be little improvement by an iridectomy and discission should be at once proceeded with.

Posterior Polar Cataract is a congenital opacity on the posterior pole of the lens or its capsule, and sometimes a line of opacity extends through the axis of the lens to the anterior surface, thought to be caused by imperfect absorption of the hyaloid artery. In these cases much may naturally be hoped from an artificial pupil, but if this fail, discission is the next step.

Pyramidal Cataract is rarely congenital, being acquired in childhood, in the following manner: A perforating ulcer of the cornea has emptied the anterior chamber, and the lens is pushed forward in contact with the inflamed cornea, when it is covered with lymph. This exudative material is drawn to a point in the shape of a cone* by the recession of the lens, when the aqueous chamber refills after the perforation has been plugged. If dilatation of the pupil show clear space and improve vision, an iridectomy may not require a subsequent discission.

Diabetic Cataract (acquired) sometimes follows the ill-nutrition of diabetes. The lens is uniformly and densely opaque, and its extraction is advisable by the method preferred by the surgeon.

Traumatic Cataract results from injury to the lens, either by actual contact of the foreign body, or by rupture of the capsule. Perhaps this effect has often unconsciously been brought about by the mere touch, which is all that is necessary, of the forceps or knife during an iridectomy or paracentesis. The lens undergoes absorption just as if a discission had been performed.

Senile Cataract is the most common and the most important. The opacity usually begins in the centre and proceeds slowly to the periphery, though it is frequently the reverse, or may begin as a diffuse affection. It rarely happens in those under fifty, and the time of ripening (extension of the opacity to the whole body of the lens) varies greatly after its inception, sometimes occupying many years. The incipient stages are extremely difficult to diagnose from a dulled and grayish translucency of the capsule in old people. By oblique or focal determination this condition simulates beginning cataract exactly. By transmitted light, at a distance of several inches, the difference is detected. If the fundus reflex is clear and uniformly red, there is no cataract, which would give a yellowish tinge and obstruct a view of the fundus.

It is highly important that the cataract we propose extracting shall be ripe. If not so, those portions of the lens which are unripe will be left in the eye, to create irritation and irremovable remains. The usual **test of maturity** is when the iris throws no shadow on the lens substance behind it while we illumine it by oblique focalized light. If a line of blackness is clearly visible, it shows the lens is still transparent at that point. Slight exceptions to this rule have been pointed out, but they are summed up in the rule that operation should be deferred if the cortex at any angle of illumination show any glitter, as from faceted surfaces or sectors, even though the iris throw no shadow. In over-ripe cataracts the cortical portions undergo degeneration and liquefy, the centre still preserving its yellowish cast, though probably displaced, by its smallness and gravity, to the lower part of the capsule. This is called **Morgagnian cataract.**

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* We lately had a patient in which this appearance was remarkably perfect. The point of the chalk-white cone seemed as sharp as a needle, and filled the whole depth of the chamber, so that it seemed about to pierce the cornea.

It is also necessary to determine the **consistency of a cataract.** A bluish-white or opalescent lens, and particularly if it be large and press the iris forward, is a soft cataract and not fitted for the usual methods of extraction. Such a lens is best removed by suction, preceded by a discission to break up the harder nucleus, if there be one. In soft cataracts the nucleus is small, and the cortex shows broad, glittering striæ. In hard cataracts the nucleus will be large, of an amber or yellowish hue, and the cortical striæ will be very fine and delicate.

Treatment of Senile Cataract.—Whether, being certain of our diagnosis, we should tell the patient plainly that he has cataract, or only "an incipient lenticular opacity," depends both upon the physician and the patient. Each case must be decided for itself. If one eye is alone affected, the other remaining good, it will be a matter of great comfort to the patient, because to await an indefinite period, perhaps years, for the ripening of cataracts in both eyes, is an inexpressibly painful condition of affairs. Sometimes tinted glasses, giving an increased diameter to the pupil, afford relief. Atropia for the same object is not advisable Both + Sph. and — Sph. lenses may be tried.

Various methods of **artificial ripening** have been proposed. Puncture of the capsule is liable to be followed by swelling of the lens and glaucomatous symptoms, and iritis may supervene. An iridectomy seems to help forward the maturing process.

Removal of the ripe cataract is not advisable if the vision of the other eye be perfect, or nearly so, because the difference in refraction renders binocular vision impossible, and the patient is not so well pleased after the operation as before.

It is not considered prudent to operate on both eyes at the same time, though both cataracts be ripe. (*See Operations.*)

Prognosis.—Different operators report highly varying percentages of success. It is important to note that success to one may not be rated as such by another. There are so many conflicting and delicate chances that positive promises are never warranted. If the patient's health be good, the tissues as elastic as consistent with age, the light perception clear and decisive, a hopeful result is to be expected. The pupil should be active, and the ocular tissues and adjuncts in a normally healthy condition. No definite degree of acuity of vision should be promised, for appearances may be deceptive, either for better or worse. Amblyopia usually coexists with congenital cataract, to render the operation less fortunate as regards sight, though highly successful as a surgical proceeding.*

RECURRENT CAPSULAR CATARACT.

Synonyms.—Secondary or Membranous Cataract; Opaque Capsule; Secondary Pupillary Membrane. The term Secondary Cataract would seem proper and fitting, but as this is applied by some authors to cataracts caused by local diseases in adjacent tissues, or to contact of the lens with vascular tissues, in contradistinction to idiopathic cataract, the term has become of dubious meaning, and hence best discarded altogether. The name given above to the affection in question accurately expresses the condition, which is a source of sufficient trouble to both physician and patient to warrant an exact nomenclature, to say the least.

Definition.—An opacity of the capsule, either posterior or anterior, remaining or appearing after removal of the lens.

Diagnosis, etc.—Shreds of the anterior portion may remain and block up the path of the light, or, as more commonly happens, the posterior portion was at the time of the operation already opaque, or becomes so subsequently. Sometimes this capsule, though not opaque, becomes shriveled or puckered, and produces a disturbance of vision quite as troublesome as if not transparent. The ophthalmoscope, by focus upon the capsule, gives the only trustworthy view of the impediments. The capsule remnants may be bound up by a membranous deposit, which will greatly modify the prognosis, otherwise very favorable.

Treatment.—*See Operations.*

DISLOCATION OF THE LENS.

Synonym.—Ectopia Lentis, Luxation of the lens.

Causes.—It may be congenital, spontaneous or traumatic in origin, partial or complete in degree, backward into the vitreous or forward into the anterior chamber.

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* Yet even here surprises may be in store. One of the authors removed two congenital cataracts from a patient sixty-four years of age, giving her immediately perfect light, color and visual acuity, and without spectacles, too.

Diagnosis.—With the ophthalmoscope the edge of the lens can be seen in partial dislocation, as a curved and narrow dark line. By oblique focal illumination the opalescent hue of the lens can be seen. The patient may complain of diplopia or distortion of objects. If the lens is in the anterior chamber there can be no trouble in seeing it. Sometimes it may pass back and forth through the pupil, according to the position of the body. Wherever the iris is not supported by the lens it will be found to be tremulous upon moving the eye, an important diagnostic sign. There is, of course, complete or partial loss of Acc., according to the degree of dislocation.

The complete dislocation of the lens is apt to set up irritation and possibly glaucomatous symptoms.

Treatment.—Complete dislocation of the lens into the anterior chamber demands its removal at once. If the dislocated lens has fallen into the vitreous, glaucomatous signs must be watched for with care. It is so dangerous to attempt its removal from the vitreous that to allow it to remain seems preferable.

In partial dislocations, if vision be not greatly interfered with, nothing should be done. An artificial pupil, away from the lens substance, often gives a happy result.

In partial luxations no spectacles will help; in complete luxations the eye must be treated as directed in *aphakia*. (*See Operations*)

DISEASES OF THE VITREOUS.

HYALITIS.

Causes.—Inflammation of the Vitreous does not arise idiopathically, but is induced by the presence of a foreign body or by choroiditis, retinitis, *etc*.

Diagnosis, etc.—By accommodating for the vitreous the proliferations of the vitreous cells, or the formations of connective tissue elements which constitute or follow the inflammation, may be detected with the ophthalmoscope, either as a diffused or circumscribed cloudiness, or as dark fragile threads or films, either fixed or floating, or again as more decided and large bands of filamentous opacities. If the inflammatory process has reached a suppurative stage the appearances have a yellowish cast. In the severe forms the opaque condition of the media renders examination of the fundus impossible. In this condition the prognosis is extremely unfavorable.

Treatment.—No local treatment of Hyalitis, as such, is advisable. Those constitutional remedies aiding in the absorption of cast-off products, especially the "mixed treatment," are commendable, and leeches to the temples also. The constant current is advisable.

OPACITIES OF THE VITREOUS,

Besides those produced by its own proper inflammation, are derived from the syphilitic virus diffused like a fine dust through the vitreous substance; or from the exudative material thrown off by the adjacent tissues; or from hemorrhages into its substance. The syphilitic "dust" will generally disappear under proper medication, while other forms are more permanent. **Mouches Volantes,** or muscæ volitantes, imperfect vitreous cells probably, are often troublesome to the patient, have no pathological signification, and yield to no treatment. **Synchisis Scintillans,** brilliant floating specks, sometimes annoying the old, are cholesterine or tyrosin crystals floating in the over-fluid condition of the vitreous sometimes found in the aged, and which render cataract operations upon such eyes very hazardous, from the ease with which the vitreous escapes.

Flocculi and specks are more frequent and annoying in the myopic. **Cysticercus** in the vitreous, rare in any country, is fortunately of extremely unusual occurrence in this country.

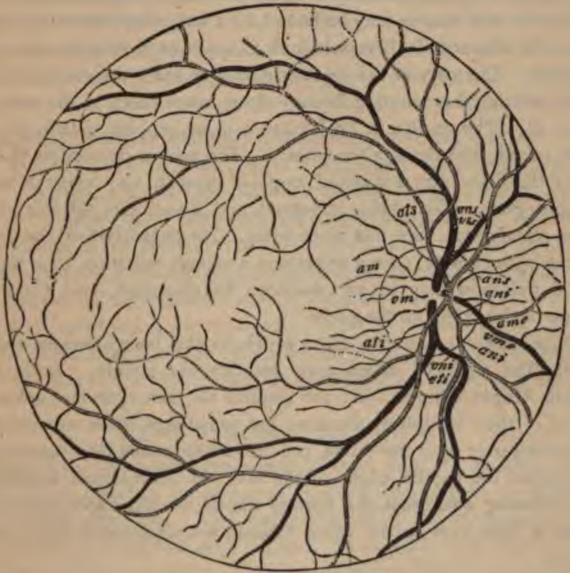
For Foreign Bodies in the Vitreous, refer to *Operations*.

DISEASES OF THE RETINA.

General Considerations.—It is in diseases of the retina that the ophthalmoscope finds its chief work and excellence, but precisely this work tests to the full the physician's delicacy of perception and fineness of judgment, to which must undoubtedly be added his length of experience. To these great natural difficulties of reaching accurate conclusions must be added the fact, that may as well be confessed, that to the ophthalmoscopic revelations of departures from the normal cannot in all, or even in many, instances be attached any absolute signification of general disease. However strong the probability, it is still more certain that the exceptions are numerous and dare not be forgotten. We know, for example, that nephritic disease must exist for a considerable period of time before there are retinal indications; we also know that in only a few cases (from 10 to 30 % are the estimates) does the retina show any lesion; and, lastly, we know that the peculiarity of the retinal appearance deemed pathognomonic not seldom exists without any kidney affection whatever. Such limitations, however, must not lead us to belittle the transcendent value and importance of retinal study. Doubtless, the failure to find a more absolute law is the fault of the observer, and not of the observed; and perhaps, also, that, as solar photography showed what the eye and telescope never saw before, so the application of this art to the retina may, if it be found possible, give us new indications and more infallible signs.*

It is certain that only much practice will give one that easy recognition of the normal retina and a sharp perception of small departures from it. There is, for instance, a condition, Hyperæmia of the Retina (which we omit from our consideration because of its lack, clinically speaking, of comparative importance), which is recognized simply as a slightly increased flush of the retina and disc combined with a hardly perceptible increase of fullness and tortuosity of the vessels; but these are changes in one fundus that are permanent, or, in other words, normal in another; so that from these facts alone we reach no diagnosis. Many other subtle hints and indications must be woven in with these.

FIG. 25.



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* The use of gaslight for illumination may conceal, by its coarse yellow glare, many indications from tint and hue which would more clearly appear with the substitution of sunshine (through a shutter hole, *e.g.*) or the electric light.

In the Normal Fundus the wide variations of pigmentation, which are purely physiological, often cause errors of judgment in the novice. The retina itself is invisible, though in some young and healthy subjects there is a beautiful phenomenon occasionally seen, called its "watered" or "shot-silk" appearance—a shimmer which flits over its surface, or centres about the macula like a half-invisible halo. It is a beautiful illustration of the interference phenomena of light, the reflections from the anterior and posterior retinal layers reaching the observer's eye in different phases, the quantity of such reflections being too weak to produce colors, as they do, for example, in exfoliated antique vases, or in any inorganic substance.

The fovea and macula may be looked for a long time before they become visible, the absence of all vessels from this spot or its neighborhood being noticeable. The arteries are relatively smaller than the veins, and show a light central line running through them, much paler in the veins, if it exist at all. The papilla in health has a clear, pinkish, gelatinous, white hue, is round, with definite boundaries The central depression, the cupping of the disc—**physiological cup**—if present, may exist in widely-varying degrees without being abnormal, and in such pits the lamina cribrosa is plainly seen, like fine sieve wires. No **pulsation of the retinal vessels** is observable, except sometimes a venous pulsation upon the disc. Arterial pulsation may be superinduced by glaucoma, and perhaps by pressure of the finger on the globe.

A phenomenon sometimes exists which, to the inexperienced eye, may simulate the signs of albuminuric retinitis too closely. It is called **Opaque Nerve Fibres.** At the papilla the axis-cylinders are usually divested of their medullary sheaths; but sometimes these are persistent, and, carried over upon the retina, produce white, comet-like patches radiating beyond the papilla edge. They have no pathological significance, only increasing somewhat the normal size of the blind spot, because the passage of light rays to the retina beneath are intercepted by the opaque sheaths.

Now, as the retina is invisible, it follows that all its indications of deviations from the normal consist in the fact of its becoming visible, and, as a corollary, it follows that whenever it becomes visible for the physician, it has *ipso facto* lessened the visual possibility of the patient.

RETINITIS—GENERAL FEATURES.

Causes.—Although cases of retinitis are met with that we cannot specifically ascribe to causes beyond the retina, the feeling is gaining ground that a strictly idiopathic retinitis does not occur. However uncertainly an *ante hoc* may be considered a *propter hoc*, we are convinced that a *propter hoc* exists. In such cases as are commonly said to occur without other lesions precedent to the retinitis—as, for example, in prolonged exposure or excessive use—the resultant affection is more the nature of a functional trouble than a true inflammation. Of *local causes* the most common is choroiditis; the retina lying in such close contact cannot but be affected by lesions in that tissue. Panophthalmitis produces at once suppurative inflammation of the retina, while optic neuritis is extended, by continuity of fibres, on to the retina. The most common sources of retinitis, however, are constitutional dyscrasiæ, of which the principal are albuminuria, syphilis, leucocythæmia, etc.

Symptoms.—The painlessness of retinitis is a noteworthy fact. Disturbances of vision are almost the only subjective symptoms. These consist, for the most part, of scotomata, dimness, metamorphopsia, etc.

Diagnosis is by the ophthalmoscope alone. **Diffuse retinitis** is sometimes met with, and is discerned as a dulling of the glowing choroidal reflex, a haziness, which must not be confounded with lessened transparency of the media, from which it is not easy to distinguish. A description of the nature of the opacities that are circumscribed will be given under the various types of clinical disease, to be enumerated in succeeding pages.

In diseases of the retina the papilla commonly shows signs of more or less direct participation and connection, either as cause or effect; but since the two tissues have a certain independence as regards their pathology, it is thought best to consider each class by itself, for the sake of clearness.

ALBUMINURIC RETINITIS.

Diagnosis.—The ophthalmoscopic signs of nephritic retinitis are considered more certainly indicative of Bright's disease than is usually the case in other affections. **The early stages** of retinal changes usually pass unnoticed because of their diffused nature and slight degrees. This is the stage of general infiltration, œdema and exudation. A grayish haze seems to be spread over the whole surface, including the papilla. Extravasations of blood are few and not easily detected.

In the advanced stages of the disease, and especially in the chronic granular type of kidney disease, yellowish white spots or patches appear, with a tendency to group themselves about the macula; these are clearly outlined, sometimes glistening in appearance. Besides these spots there is generally a broad, encircling splash of sunshine about the papilla, which last shows indistinct edges and hazy outlines. Hemorrhagic spots are now marked, and may become blended in larger blotches over the general ground.

Prognosis depends upon the clearness and certainty of the diagnosis, together with the prognosis of the general disease. If this improve or recover, and unless the disorganization have proceeded too far in the retina, there will generally follow much clearing up, and improvement of vision will ensue, the extravasations becoming absorbed. But when the papilla has been largely implicated, and there has been much œdema of the retinal tissues (sometimes this swelling even produces hypermetropia) and severe hemorrhages, atrophy of the nerve and retinal elements follows, regardless of the cure of the general disease, with a certain progress to blindness. The most favorable prognosis may be given in albuminuria from fevers, pregnancy, etc.

Treatment.—Except the local abstraction of blood in acute stages of the disease, the treatment consists wholly of constitutional measures to reinstate the normal activity of the kidneys. It is possibly of advantage to quiet the ciliary muscle with weak atropia instillations, to lessen its irritative action upon the choroid. Rest, and in severe cases bandaging the eyes, are, for the same reason, to be advised.

Diabetic Retinitis is by the ophthalmoscope indistinguishable from albuminuric, so that the urine should be tested with this idea in mind.

SYPHILITIC RETINITIS.

Diagnosis.—The initial stages are the same as in albuminuric retinitis: Hyperæmia, serous exudation, a grayish or bluish-gray film-like veiling of the retina and papilla, increase of tortuosity and dilatation of the veins, with proportional attenuation of the arteries. At a more advanced period, the white dots and spots about the periphery of the fundus are less brilliant and glistening than in the albuminuric type, and are more changing than these. The large spot of papillary opacity is also far less frequently present.

Extravasations of blood, though occurring, are less apt to be so frequent and pronounced as in the preceding form, while the synchronous inflammation of the choroid, iris, etc., is most certain to take place, rendering the diagnosis more sure. The vitreous and aqueous opacity is probably increased.

The progress of the disease is more rapid, amblyopia setting in early, and in a marked degree. Nyctalopia is a common symptom, and metamorphopsia occur. Inherited or acquired syphilis may produce the retinal affection. The prognosis is a little more favorable than in albuminuria.

Treatment.—Purely constitutional.

LEUCÆMIC RETINITIS.

Besides the common characteristics of diffuse retinitis and pale extravasations of blood, there is one distinctive sign—a palish-yellow hue of the whole fundus. There is pallor of the vessels, the arteries having the more saffron tint.

ANÆMIC RETINITIS.

It is certain that progressive pernicious anæmia may be attended with marked retinal lesions. Inflammatory changes may not be marked, but white patches often occur, and there is a notable tendency to hemorrhages in the region of the papilla. The marked pallor of the fundus and arteries is the most notable and constant ophthalmoscopic sign.

ISCHÆMIA RETINÆ.

Of rare occurrence and unknown cause. The symptom is complete loss of sight of both eyes; the retinal arteries are emptied of blood, or are mere threads; the veins greatly reduced. Under the influence of tonics, the return of blood and of vision occurs within a few days. It is generally bilateral.

RETINITIS PIGMENTOSA.

Definition.—A pigmentary degeneration (rather than inflammation) of the retina.

Causes.—This slowly-progressive, incurable, chronic malady is most commonly an inherited affection, found most frequently in the descendants of consanguineous marriages. Inherited syphilis may be held accountable for some cases. Though generally appearing in childhood, the almost certain blindness may not arrive till in old age, though great limitation of the field, nyctalopia and other defects of vision early begin their fatal march.

Diagnosis, etc.—The earliest subjective symptom is inability to see well at night, to which is soon added the inability to see well at any time except directly in front of the eye.

By the ophthalmoscope the retina presents a very characteristic appearance. Dark streaks of pigmentation, like tree moss in shape, trail over the fundus, without any order or preference of place, except that they begin at the periphery and gradually draw toward the macula. These have been likened to the Haversian canals of bone. In some cases the disease is said to exist without this pigmentation. The prognosis is bad.

Treatment consists in persistent use of the constant current, by which cases have been known in which the progress of the disease has been arrested, and the fields of vision enlarged, and this is all that can be hoped for.

RETINAL HEMORRHAGE, OR APOPLEXY.

Causes.—The variety here considered is not connected with retinal inflammatory process and may occur idiopathically or as a result of other lesions. The most common sources are the atheromatous condition of the vessels in old age, hypertrophy of the left cardiac ventricle, as a result of paracentesis or other sudden diminution of intra-ocular pressure, sudden increase of the tension, as from cough, muscular strain or pendant position of the head. Disturbance of vision, of course, is proportional to the extent of the hemorrhage.

Diagnosis.—By the ophthalmoscope.

Prognosis.—According to the severity of the hemorrhage and its central position. If the macula is attacked the prognosis is bad. If the vitreous is reached by the blood, glaucoma may be produced, possible detachment of the retina and certain scotomata that will probably be permanent.

Treatment.—Rest, dry cups or leeches to the temples, application of cold to the eyes, and careful attention to general therapeutics.

HEMORRHAGIC RETINITIS

Unites with the preceding symptoms those of inflammation of the retinal tissues themselves; is caused by much the same lesions as simple hemorrhage. There is more regularity in the appearance of the blotches, often being called flame-like in appearance. The prognosis is worse than in the last preceding case, the treatment the same. The primary cause is always to be sought for.

THROMBOSIS AND EMBOLISM OF THE RETINAL ARTERY.

Symptoms.—Rapidly progressive blindness beginning at the periphery and quickly proceeding to the centre.

Diagnosis.—The differential diagnosis between thrombosis and embolism is not clear. There is pallor of the disk and retina, diminution, even to a thread, of the arteries, and to a less degree of the veins, a grayish-white opacity appears at the posterior pole, because of failure in nutrition; the macular standing out sharply by contrast with the surrounding white. Atrophy of the disc and retina are apt to follow and the prognosis is very unfavorable.

Treatment is of no avail unless it be massage of the eyeball, which should be tried, in the hope of removing the embolus. Temporary losses of sight are indications for the necessity of such general treatment as shall restore vigor to the general circulation.

BLINDNESS FROM INTENSE LIGHT.

There have been cases of partial or complete loss of sight from exposure of the eye to the sun or electric light. A central blind spot is produced, the ophthalmoscope showing an opaque spot of white at the macula surrounded by a ring of congestion. This is probably due to a coagulation of the albumen of the retina. The prognosis is bad, as the central scotoma will probably remain, despite all leeches, electricity or hypodermatic injections of strychnia, which may be tried.

DETACHMENT OF THE RETINA.

Causes.—Fluid albuminoid effusions between the retina and choroid which themselves may have many origins. Myopia of high degree (posterior staphyloma) is said to cause 50 per cent. of this distressing malady. Blows and injuries may give rise to it, diseases of the vitreous and intraocular tumors can also produce it.

Symptoms.—Loss of vision, corresponding to the detachment. If, as is usual, it be below the horizontal meridian of the eye, objects above are not seen.

Diagnosis.—If the detachment be in its incipiency or fresh, it may not have lost its red reflex, and hence the trouble escape the eye of the examiner. When more advanced in its progress, the red reflex fails where the detachment begins and a blueish-gray curtain is seen waving freely in the fluids with motions of the eye. The vessels appear black and sometimes hidden by the folds. This dark portière-like curtain may sometimes be plainly seen by the naked eye.

Prognosis is unfavorable, though the progress of detachment may be arrested generally.

Treatment consists in tapping the sclerotic beneath the curtain and drawing off the sub-retinal fluid.

GLIOMA OF THE RETINA.

Definition.—A malignant tumor of the retina.

Cause.—Idiopathic, often congenital ; ultimate cause unknown.

Symptoms.—Occurs in young children only ; generally is noticed in the first year or two of life. Its early stage gives no intimation of its existence by pain, and though blindness has set in some time before the glioma becomes visible by others, yet, from the age of the child, no notice of this blindness is taken.

Diagnosis.—Up to the time the growth becomes visible by the naked eye through the pupil, pain, swelling or signs of inflammation have not made themselves noticeable. A shining, glistening white appearance may be seen behind the pupil. The tension is either normal or subnormal. The sad thing about this disease is that the child is not generally brought for treatment till this stage is past, and then it is usually too late even to save the little patient's life. In the second stage the growth has begun to push its way forward, carrying retina, lens and iris with it, tension becomes greater, pain, congestion cloudiness of the cornea, mydriasis, *etc.*, ensue in rapid progress. The lens remains clear, through which the white or yellowish-white surface of the tumor is seen. If allowed to proceed the growth will soon break through the eye in front, while it is creeping up the optic nerve to the brain, and even invading the bones of the orbit.

Treatment.—Enucleation of the eye at the earliest moment of certain diagnosis* is the only hope of saving the patient's life. The nerve must be divided as far back as possible, and microscopical examination of the severed nerve will show whether the growth has proceeded past this point; if so, danger of glioma of the brain renders the prognosis very grave. If the tumor has pervaded the tissues of the orbit, such must be removed, and even the walls of the orbit treated with chloride of zinc.

DISEASES OF THE OPTIC NERVE.

PAPILLITIS.

Synonyms.—Optic Neuritis; Choked Disc; Neuro-retinitis. The terms choked or swollen disc presumed an unproved, now a disproved, theory of the cause of papillitis, and have been discarded.

Definition.—An inflammation of the optic nerve, showing its most marked signs at the papilla within the globe.

Causes.—Intracranial disease is estimated to cause four-fifths of all cases of papillitis, and of the encephalic diseases, tumors are responsible for by far the greater number. Meningitis, especially tubercular, perhaps comes next in order. As to the manner in which cerebral lesions set up inflammation of the papilla, we cannot enter upon here. We have purposely left out of this compend a consideration of pathological anatomy, and in this case the diversity of theories and lack of certainty make the omission all the more excusable.

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* Suppurative hyalitis and choroiditis, or fibrous white retinal deposits may produce symptoms so closely simulating glioma that they have been called **Pseudo-Glioma.** It is needless to speak both of the necessity of caution and the danger of delay. In pseudo-glioma there will usually have been some previous history of eye trouble. One quite certain diagnostic sign is, that in glioma the iris will be pushed forward, while in the pseudo-glioma the iris will be in its normal position, or retracted.

It is also certain that general diseases, such as syphilis, diabetes, typhoid fever, amenorrhœa, lead poisoning, etc., may produce the affection in question, while orbital tumors, caries or periostitis may also have the same effect.

Diagnosis.—By the ophthalmoscope alone. The typical appearance of the papilla while undergoing inflammation is what has been called its *woolly* appearance, united with swelling and hyperæmia and with venous congestion. (See Fig. 26.)* The edges of the disc are lost, and a striated, flame-like or grayish haziness spreads over the face and short distances upon the retina, streaming, as it were, from the centre over the edges of the disc nearly equally upon all sides. The swollen condition of the disc is proved, without anatomical examination, by the necessity of throwing up higher + Sph. lenses, in order to view it clearly, thus showing its advance toward the front of the eye. In severe forms white spots and dots appear about the macula, indistinguishable from those in albuminuric retinitis. There is an affection in whose early stages the disc appears as if suffering under a slight papillitis, and, later, simulates complete atrophy. It is called Tobacco Amblyopia, Chronic Retro-bulbar Neuritis or Central Amblyopia. Tobacco is the usual cause, though alcohol may aid; exposure to cold and wet may also produce it.

It is remarkable that undisturbed vision continues for quite a time in this condition of the papilla. Finally, visual acuity is dulled, or even obliterated, and color perception is always especially deranged. The disease is usually binocular, and its progress slow and painless.

It is thus seen that this affection gives no certain indication of general disease; it only gives probabilities, or strengthens diagnoses derived from other sources than the papilla. If, for example, it were probable that lead poisoning or syphilis were at their destructive work in the system, and the eye ground gave the signs of papillitis, we should consider it a great corroboration of previous diagnosis, though a small proportion of cases of papillitis are due to either of these causes. If other indications point to coarse encephalic lesion, the existence of papillitis renders the diagnosis almost infallible, though, so far, we cannot locate the lesion from any signs given by the ophthalmoscope.

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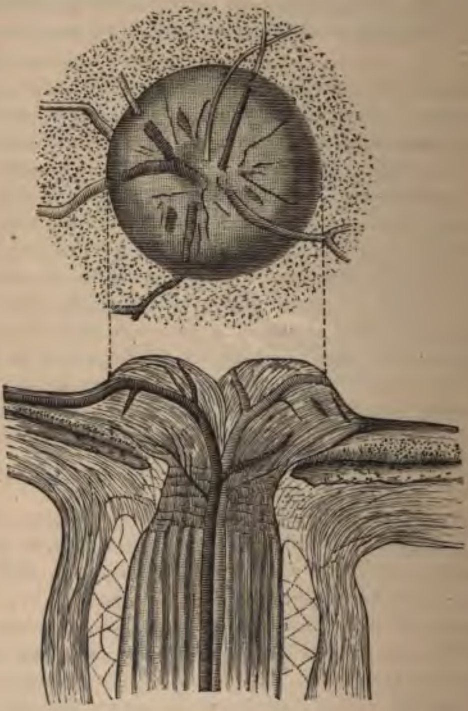
* The edges of the papilla in the illustrative cut, from Schmidt-Rimpler, are too sharply outlined; as, in a typical case, it is impossible to distinguish where the papilla passes over into the general fundus.

A clear distinction as to location of initial lesion lies in the monocular existence of papillitis, which, quite certainly, proves the pressure to be this side the chiasm, and so, probably, orbital in origin. But there have been at least six well-attested cases of cerebral tumor in which only one optic nerve was affected, and these are enough to make one modest.

FIG. 26.



Prognosis.—As regards sight, it is usually unfavorable, though every special case requires the aid of the general diagnosis and prognosis, to become definite or approximately accurate. In pronounced papillitis it is not, as a general rule, usual to find any, or but little and slow, regaining of lost visual power. It is considered well to retain what is left.

Treatment.—As papillitis is entirely symptomatic, its treatment is one with the general disease causing this and other symptoms, from the study of all of which only a trained judgment will be able to formulate the right therapeutic agent. The iodides and bromides will be used in encephalic lesion, mercurials and iodides in syphilis, tonics in menstrual disorders, etc. When the indications are that the pressure is orbital in location, diagnosis and treatment are of the extremest doubt and uncertainty. In tobacco amblyopia, total abstinence is imperative.

ATROPHY OF THE OPTIC NERVE.

Causes.—It is believed that atrophy of the nerve may be idiopathic ("primary"), but the vast majority of cases are "secondary," proceeding from retinal or from cerebral lesion, or from pressure along the course of the nerve, in most of which cases it succeeds some form of neuritis. The greater number of cases are certainly due to diseases of the brain and spinal cord, while tobacco, alcohol, traumata and syphilis do not fail each to bring his quota. Its connection with locomotor ataxia is not to be forgotten.

Symptoms.—Visual acuity is lessened, color perception is disordered and the field retracted in varying degrees, according to the progress of the disease. There is no pain, and seldom photophobia.

Diagnosis.—The ophthalmoscope shows, usually, a pallor of the disc, instead of the rosy, healthy hue of the normal disc, though instead of this dead paleness, it has a distinct bluish hue sometimes, and, too, a grayish or yellowish cast. Its outlines have a hard sharpness, producing altogether a striking or staring appearance; the lamina cribrosa is usually visible. It must be remembered that mere paleness may exist without atrophy, as in anæmia and tobacco amblyopia, but the loss of transparency, hardness of outline, etc., must be considered with other symptoms. The color of the atrophied disc is not, certainly, indicative of special causes.

Prognosis.—Probability of retaining the vision yet left is small. The progress is generally from bad to worse.

Treatment.—We must seek the cause. Locally, the weak constant current and strychnia hypodermatically injected may be tried till proved of no avail.

GENERAL DISEASES.

GLAUCOMA.

Cause.—Glaucoma is characterized by an increase of intraocular tension or pressure above the normal. All the catalogue of woes is, in this disease, a simple result of this fundamental condition. There are many theories, about one to every writer, hoping to explain the origin of this heightened tension; but two chief ones have occupied the most attention. They might be spoken of as the theory of hyper-secretion and that of the retention of the intraocular fluids. To irritation of the nerves governing the secretory functions was attributed the excessive amount of fluids. The retention theory has probably the greater number of supporters at the present time, though it is assuredly open to severe criticism. It is well known that the effete fluids pass out of the globe principally by the way of the ligamentum pectinatum and canal of Schlemm, and in glaucomatous eyes it is found that the periphery of the iris lies in contact with the cornea and thus dams the outlet. Rigidity and shrinking of the sclerotic, swelling of the ciliary processes, are other theories. More plausible is the ingenious and able explanation advanced by Priestly Smith, which attributes to increased lens size (that always takes place with age) a diminution or obliteration of the space between the edge of the lens and the ciliary processes, called the canal of Petit. This so-called canal is the route through which the excreted fluids of the vitreous chamber pass forward to the canal of Schlemm, and if this be blocked, the increased pressure from behind will throw the lens forward and effect the shutting off of the canal of Schlemm by the iris, as alluded to above, and which is left unexplained by others. The rarity of glaucoma in myopia, as compared with hyperopia, leads to the conclusion that the formation of posterior staphyloma may be of the nature of a relief of the pressure backward instead of the iris being pushed forward, and that in this way progressive myopia takes the place of what might otherwise result in glaucoma. But such cases are exceptional.

Varieties and Symptoms.—**Glaucoma Simplex** is unaccompanied by inflammatory symptoms; it may become chronic and continue with a tension only slightly above the normal for years.

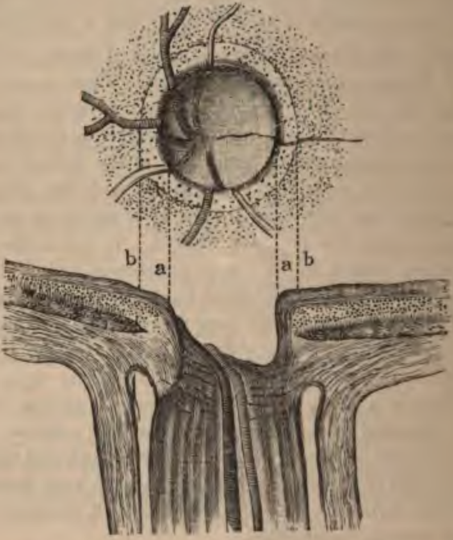
In **Acute Glaucoma** there is a class of symptoms which is called premonitory, but how these symptoms could appear *before* an actual increase of pressure has taken place is for us impossible to see. These so-called premonitions are, *e.g.*, a sudden failure of accommodative power, stronger + Sph. glasses being required for reading; fogginess of vision and colored haloes about a light are also noted. These symptoms show a ***premonitory*** *attack*, which may pass off to recur at a later time. These short attacks may be numerous without being sufficiently severe to catch the patient's attention, though usually each attack leaves the eye in a worse condition. When a more severe or abiding increase of pressure sets in, it may be accompanied by vomiting and other derangements of function, tending to deceive both patient and physician. Sometimes the first noticed attack begins with fury, and in a few hours vision is wholly destroyed. This is v. Graefe's **Glaucoma Fulminans.** **Subacute** attacks are characterized by exacerbations and remissions of intensity without complete relief at any time. **Absolute Glaucoma** is glaucoma that has culminated in blindness. There is here no lessened tension, and the end is cataract, staphylomata, atrophy and disorganization of special organs, and of the globe itself.

Diagnosis.—The principal diagnostic sign is, of course, the characteristic feature of the disease—**Increase of Tension.** There is no other method of testing this but the *tactus eruditus*. The two index fingers are laid delicately on the closed lid, the hands supported by the other fingers on the forehead or temple, and an estimation of the tension made by soft palpation or alternate pressures. Comparison with the other eye of the patient is advisable and with normal eyes, upon which last much previous practice will only give the precision desired. T. + ? is the symbol of a possibly increased tension, as T*n*. means the normal, and T. + 1, T. + 2, T. + 3 indicate the varying degrees of hardness up to the last or a stony hardness. The *minus* sign with the same figures means diminished degrees, T. — 3, *e.g.*, indicating a perfectly flaccid condition of the globe.

Perhaps the second in importance of the diagnostic signs, like all the others to follow, is a mere result of the abnormal tension to which the tissues were subjected; this is **anæsthesia of the cornea.** Direct the patient's eye upward to get the visual axis out of line, and then touch the cornea with a twist of absorbent cotton or silk, and what would otherwise cause spasmodic shrinking, etc., is hardly perceived, showing the pressure has paralyzed nervous transmission.

Amplitude of Acc. is lessened for the same reason, and again, for the same cause, there is **dilatation** and comparative **immobility of the pupil.** **Cloudiness of the cornea** is produced by pressure, as is readily shown in excised pigs' eyes, and there is congestion of the veins. These are the chief external signs. If the fundus oculi be visible, **arterial pulsation** (which is always pathological) exists upon the papilla, or is producible by the slightest pressure. The infallible indication, however, is the **cupping of the papilla** (Fig. 27), easily distinguishable from the "physiological cup" by its extent, depth and the fore-shortening, or even disappearance, of the vessels as they climb up and over the precipitous sides of the tip. Here, instead of requiring + Sph. lenses to bring it into clear view, we have to rotate in — Sph. lenses, as the bottom of the cup lies further from us than the retina or the brim of the cup. About this brim the "glaucomatous ring" is seen in chronic simple glaucoma. Contraction of the field of vision and loss of color perception are, of course, synchronous with diminished acuity and heightened tension, and it need not be added that pressure upon sensory nerves produces the most exquisite pain, as also that the abnormal pressure must induce inflammatory symptoms in many parts of the eye or adjacent tissues.

FIG. 27.



Treatment.—Eserine, it is certain, has a tendency to reduce the intraocular tension, and when an iridectomy is not at the time advisable or possible, perhaps, also, always, as a tentative or preliminary proceeding, its frequent instillation should be tried before proceeding to the operation that is most widely recognized as the most effectual check, and possibly cure, that is known. In what manner and why, beyond the merely temporary effect of relieving the pressure by the momentary escape of fluids, v. Graefe's great discovery accomplishes the desired end is not certainly made out, because there is no unanimity of opinion upon the question of the etiology of glaucoma itself. It is generally admitted that sclerotomy and paracentesis (*see Operations*) do not so surely and permanently reduce the tension as iridectomy. That it does not always succeed, nay, is far from it in chronic cases, seems to prove the theory of Priestly Smith, because, if the iris blocks the exit through the ligamentum pectinatum of the effete aqueous fluids, and thus *alone* raises the intraocular pressure, the bit of iris removed would at once equalize the secretion and excretion; but if the expanded lens tends to close up the vitreous outlet, and in this way creates a partial and the incipient heightening of pressure, an iridectomy would not always relieve, though generally alleviate. Precisely, too, in the chronic cases where the abnormal advance of the lens and iris by the vitreous pressure had become settled and rigid, would be the cases in which, *à priori*, the most failures would be expected.

In glaucoma one eye is usually under greater pressure than the other, but the second is quite sure to follow its fellow in time, one of the disadvantages of operation being a tendency to set up acute symptoms in the normal eye.

Hemorrhage of the retina is sometimes followed by a development of glaucoma, called **Hemorrhagic Glaucoma.** In such cases an iridectomy has not proved beneficial, but the reverse.

SYMPATHETIC OPHTHALMITIS.

Definition.—An inflammation of the ciliary body, iris or choroid of one eye, caused by an irido-cyclitis of its fellow.

Cause.—How the inciting condition is conveyed to a normal eye, and there sets up a like inflammation, is at present not known. There are many theories, as a matter of course. The ciliary nerves, the optic nerve, the blood vessels, the lymphatics, and even the blood itself, with and without the aid of bacteria, are each conjured with. By the way of the chiasm, along the optic nerve, seems, from late investigations, to be the most probable route.

Conditions and Character of the Process.—The inflammation of the exciting eye is always of the ciliary body and iris, the choroid and other tissues often being implicated; and this irido-cyclitis is almost invariably the result of a trauma, or of a foreign body lodged in the ocular tissues or within the globe. The dislocated lens, acting as a foreign body, has been known to induce sympathetic ophthalmitis. The induced inflammation does not make its appearance sooner than fourteen days after the decided appearance of the inciting inflammation in the injured eye, though years (even 40) may elapse before such secondary inflammation appears. The induced affection is like that of the exciting eye, *i.e.*, generally an irido-cyclitis.

The kinds of wounds or injuries almost certainly provocative of this cyclitis are those of the ciliary body. If a perforating wound pierce the "dangerous zone," the circumcorneal ring, one-fourth of an inch wide—the results must be watched with the greatest anxiety. If suppurative signs begin to appear, then the danger is at its height. The implication of the iris in a wound which may not be in the dangerous zone tends to bring on the same fatal march of events.

Diagnosis.—However dangerous may be delay, haste may be equally as productive of mischief. This is illustrated by the mistake of diagnosis that one is liable to make, which is to confound **Sympathetic Irritation** with **Sympathetic Ophthalmitis.** Asthenopia, photophobia, lachrymation and functional weakness of the ciliary muscle, of themselves, would not warrant any diagnosis except that of the first mentioned. The real ophthalmitis may or may not follow a shorter or longer period of such sympathizing irritation; it more commonly begins its course without it, and insidiously. The beginning of the inflammation in the sympathizing eye is generally preceded by slight, though marked, exacerbations of inflammation in the exciting eye. Extreme tenderness is remarkable about the ciliary region. Cyclitis soon becomes apparent, though the iritis is less marked, and keratitis punctata is an almost constant and highly valuable sign. Tough synechia will follow continued iritis, as also the formation of new vessels in the iris. With continuance of these inflammations, either glaucoma will supervene or shrinking and atrophy of the globe, the lens having become cataractous in either case. The process, however, is prone to relapses, and lengthened periods of time may elapse before irremediable blindness ensues.

Prognosis.—When thoroughly started, sympathetic ophthalmitis almost infallibly proceeds to a fatal ending, despite all treatment.

Treatment is, therefore, preventive, and the only certain preventive measure is enucleation of the injured eye. The following rules are advised; it is better to enucleate—

1. If the injured eye be hopelessly blind.

2. If the injury be of such a nature that blindness, though not yet present, is inevitable.
3. If there has been severe perforating wound of the ciliary body and injury to vision, with succeeding development of cyclitis.
4. If a foreign body be in the eye, impossible to extract, and cyclitis set in.
5. Upon the appearance of marked signs of increased tenderness, a blind eye should be removed, though no injury has caused the tenderness, and regardless of however long the blindness has existed.

These recommendations are based on the supposition that the possibly sympathizing eye has at least fair vision. If this should be highly defective or afflicted with some hopeless disease, more room may be given the inciting eye to realize its own improbable cure and to fail in exciting its fellow.

If the inciting eye retain any share of vision, then no rules can help in reaching the extremely difficult conclusion, whether to enucleate or not. If the injured eye contain a foreign body, enucleation should be postponed until decided irido-cyclitis has appeared in it, and if sympathetic ophthalmitis have already set in, enucleation of the inciting eye, if it have any vision present or prospective, is inadvisable.

Treatment of the sympathizing eye involves immediate and frequent instillation of atropine drops (F. 13), complete rest of body and eye, bandages over the eye, careful attention to such measures as may reduce local inflammation and promote the general excretion of waste products. F. 36 is recommended.

EXOPHTHALMIC GOITRE.

Synonyms.—Graves' Disease; Basedow's Disease.

This disease is characterized by palpitation of the heart, enlargement of the thyroid gland, and proptosis or protrusion of the eyeballs. This ocular peculiarity is purely symptomatic, requiring no local attention. The treatment is that of the general disease.

PART IV.

SURGICAL OPERATIONS,* ETC.

Instruments.—The principal instruments required by the ophthalmic surgeon are as follows:—

Two or three fixation forceps, of different styles of strength and teeth.
A stop-spring speculum.
v. Graefe cataract knives.
Cystotome.
Iridectomy scissors.
Iris forceps.
Cataract spoon.
De Wecker scissors.
Lid elevators.
Meibomian scoop.
Ligature forceps.
Horn spatula.
Weber's canaliculus knife.
A set of lachrymal duct probes.
Strabismus scissors.
Strabismus hook.
Discission needles; one pair with stop.
Sichel's cataract knife.
Enucleation scissors.
Tyrrell's hook.
Triangular keratome.
Snellen's or Knapp's clamp.
Corneal spud.
Tattooing needles.
Curved needles, silk thread, etc.
(Electrical apparatus.)

Illustrative cuts of these instruments, slightly reduced in size, are shown on later pages, and the instruments may be had of Mr. Snowden, either separately or in a case complete, as desired.

DISTICHIASIS, TRICHIASIS AND ENTROPION.

By Electrolysis.—When only moderate inversion is present, or the errant hairs are few, electrolysis is the most certain and least disfiguring method of relief. Epilation does no permanent good. The lid is clamped, and a fine needle attached to the negative pole of a Leclanche battery. The positive pole is placed on the temple, the needle thrust into the bulb of the lash and the circuit closed. The bulb is destroyed, so there is no regrowth. Each lash has to be treated separately.

Illaquætio.—One or a few isolated hairs may be given a different direction, away from the ocular conjunctiva, by drawing each one through a separate needle hole with a loop or lasso made by threading a needle with both ends of a silk suture. The puncture is close to the abnormal exit of the lash—the direction of the counter-puncture that of the desired direction of the hair.

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* Operations for removal of tumors, warts, epithelioma, etc., have been omitted, both as to description and treatment, because belonging to general surgery primarily. For the same reason, the consideration of the subjects of dressing, sutures, etc., have often been left out.

By Excision.—A small bunch of lashes may be excised by a V-shaped incision from the inner margin (after dissecting away the conjunctiva), which shall include the bulbs of the offending hairs.

By Transplantation.—The Arlt-Jaesche operation consists in splitting the lid along the whole intermarginal edge for about 5 mm. deep, the anterior portion containing the integument, cilia and bulbs and the orbicularis muscle. The skin of the lid is now incised about 5 mm. from the margin, and parallel with it, for nearly its whole length. We then make a curved incision above this, starting from either extremity and returning to the opposite end, so that we have a semilunar-shaped island of skin to be dissected off. The height of this fold, is of course, proportional to the effect desired. After the removal of the semilunar riband of integument, the lid margin, with its cilia, is brought into apposition with the upper edge of the semilunar space and fastened by sutures.

FIG. 28.

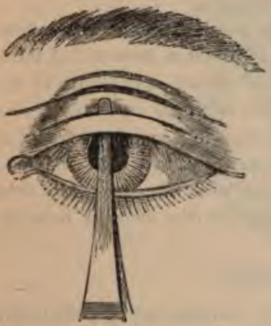
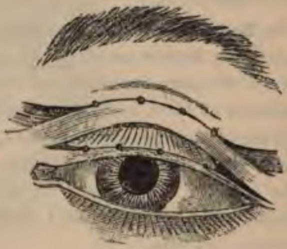


FIG. 29.



Burow's Operation gives excellent results in cases of moderate inversion; the lid is everted over a spatula placed first upon the lid, and a line of incision is made *through the cartilage*, parallel with and three mm. from the free border of the lid. The integument is not to be cut through. The gaping of the wound gives the desired eversion.

By Grooving the Tarsus Streatfeild and Snellen remove a wedge or broad V-shaped portion of skin, muscle and cartilage, the length of the lid and 2 to 3 mm. from its edge, which everts the cilia into their normal position, when the edges of the excised portion are brought into union.

Dianoux's Operation has given us better results than any other. The integument is cut through parallel to the edge and about 4 mm. from the same, the incision reaching to the cartilage only. On the intermarginal edge the lid is split between the cartilage and muscle till the knife meets the preceding incision at right angles to it, thus forming a bridge of lid edge containing the cilia and their roots. Another and slightly longer line of incision is now made, parallel with the first one, through the lid integument and about three mm. above it, and the riband of skin between the two is dissected up in the middle and left attached at both ends. The bridge of lid margin is then drawn up and over the riband of loose skin and fastened by sutures to the upper border of the highest incision, while the integument riband is drawn down beneath and stitched to the intermarginal edge. (See Figs. 28, 29.)

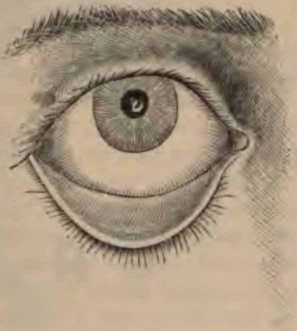
In **Senile Entropion** excision of an ovoid piece of skin, with the underlying muscle, parallel with the lid edge, often does well if there be not too excessive inversion and flabbiness of the adjacent skin. If so, the operation of Hotz has been recommended, in which an excision of skin and muscle is made down to the tarsus, some 4 to 6 mm. from the lid edge, and shaped like a railroad cutting. The tarsus is laid bare, and the two skin margins drawn to it by sutures, and held till union with them is effected, thus giving a solid *point d'appui* for the everting force of the cicatrice and skin.

ECTROPION.

Senile Ectropion (Fig. 30), is usually accompanied by a thickening of the subconjunctival tissues. In such cases we have had perfect success by the following method of operation :—

An intermarginal incision is made the length of the lid, about 2 mm. from and parallel with the margin. The conjunctiva is dissected off, and a V-shaped body, as viewed in profile, of the hypertrophied tissue excised the length of the lid, according to the degree of ectropion and the excise of tissue present. (See Fig. 31.) The edge of loose palpebral conjunctiva is then trimmed to the required width, when the lid shall be placed in normal position and adjusted to the pared surface of the lid. A strong silk ligature, threaded with a long curved needle at each end, is then, by one of the needles, passed through the whole substance of the lid from a point 6 or 8 mm. to one side of the centre and 2 mm. below the insertion of the cilia. The needle (after having drawn the thread through the lid a few inches) is then passed through the fold of the conjunctiva as it turns upon the globe, and, with a careful estimate of direction, pressed downward through the tissues immediately beneath the skin of the cheek, emerging upon the cheek 1¼ to 1½ inches below the eye. The needle at the other end of the thread is entered about 3 mm. from the first insertion, toward the angle of the eye, and carried through the lid, conjunctival fold and cheek, parallel to the first. A second thread, with two needles, is used in the same way at an equal distance beyond the centre of the lid, on the other side. A bit of rubber tubing is placed under each loop before making tension. The lid is now drawn into proper position by careful tension upon the free ends of the ligature of the cheek, which are then tied, pieces of drainage tube being used beneath the knots, to keep them from burying themselves. The appearance of the ligatures is shown in Fig. 32.

FIG. 30.



Within twenty-four hours the lid will have swollen so that the pieces of rubber tubing can be withdrawn, to keep the threads from cutting into the flesh, and within three days the threads may be severed and carefully extracted. We first used this operation in May, 1883, and with unfailing success ever since. No sheet lead is required, the eye need not be bandaged, nor the occupation of the patient, as a rule, interrupted.

Complete excision of a V-shaped piece of the whole lid (seen from the front) is not, in our estimation, advisable.

Traumatic or Cicatricial Ectropion, caused by scars, burns, etc., was at one time extensively treated, by partial removal of skin from the temple, cheek or forehead, a proceeding highly inadvisable, as, owing to the unsightly wounds produced, the cure is often as bad, or worse, than the disease.

By **Transplantation** of a mass of skin from other parts of the body, remarkable cures have been effected, though the operation is not always certain. We have had better success by leaving the piece to be transplanted rooted in the patient's arm till it has become fixed in its new position. This, of course, requires greater care and patience, both of surgeon and patient, than many are able to give.

FIG. 31.

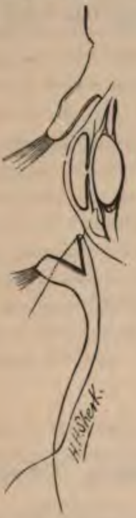
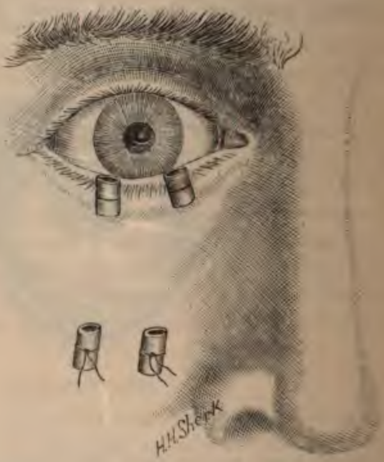


FIG. 32.



Probably the best method of relief is by numerous **small skin grafts** made upon the artificially-produced granulating surface. This requires a preceding dissection of unhealthy skin and tissue, a loosening of the skin when too tensely drawn, and the production of a free and healthy granulating surface as a bed for the bits of skin, about two mm. in diameter, which, if there be no objection, may be most advantageously taken from the smooth part of the forearm. Their healthy, pinkish appearance, at about the third day, shows that they have taken root in the new soil. The part should be covered with a piece of oil silk and firmly bandaged.

Symblepharon, or adhesion of the lid to the eyeball, if not too extensive, is best treated by ligature, after which the part attached to the conjunctiva of the globe atrophies and falls away. If a large surface be covered by the attached lid, transplantation of the conjunctiva of a rabbit, or of a piece of the vaginal mucous membrane, has proved most effective, but is, at best, an unsatisfactory procedure.

Blepharophimosis, or a narrowed and contracted condition of the outer canthus, is remedied by dividing the tissues with strong scissors in such a manner that the palpebral opening may be symmetrically and sufficiently widened, and uniting, by sutures, the conjunctiva of each eye with its corresponding skin portion, so that the flush edges completely meet and cover the underlying tissues.

Ankyloblepharon is the reverse of this; the lid edges are pared, brought in contact by sutures, and thus held till they unite. This is called Tarsoraphy.

For **Ptosis,** when other means have failed, a surgical operation may bring relief. It consists simply in excising a piece of the skin and underlying tissues down through (but no further than) the orbicularis, and bringing the edges together. The width and length of the excised piece must, of course, conform exactly to the retraction desired. The danger of removing too wide a piece need not be emphasized.

Pagenstecher advises a proceeding designed to transmit the action of the occipito-frontalis muscle to the lid by means of cicatricial tissue. This is produced by the passage of a strong thread subcutaneously from the supra-ciliary margin to near the lid edge and tying the two ends with moderate tension, which last is increased till the ligature cuts its way out.

Removal of Chalazion.—Evert the lid,* and make a free and somewhat deep incision parallel with the margin of the lid through the cyst. Scoop out the contents thoroughly with the Meibomian scoop.

Closure of the Lachrymal Duct.—For slitting up the canaliculus (the lower is the only one generally operated on), we use a Weber's canaliculus knife. The *punctum* is a minute, brownish dot near the inner canthus, into which the bulbous point of the knife is inserted, the surgeon standing behind the patient supporting the head against his body. The knife is then dropped to about twenty degrees below the horizontal position, with the cutting edge inclined toward the globe of the eye at an angle of about forty-five degrees. The lid is held by firm tension of the thumb of the other hand upon the tissues just beneath, so as to draw the lid against the knife as it shall move toward the nose. The position of the hands is shown in the annexed cut (Fig. 33). The knife is now advanced endwise toward the sac till the point of the blade reaches the solid wall of the same, the canaliculus being mostly divided by this advance. The tension of the other thumb upon the cheek is still kept up while the handle of the knife is swept into a vertical position, the point being kept as a pivot in the sac. The cutting edge is now against or turned toward the nose, and in this position a slight downward push is given it to effect thorough division of the sphincter muscle of the sac. The cutting edge is now rotated one-fourth circle outward, so that it faces straight forward, the general direction of the whole knife pointing, like the nasal duct itself, downward, slightly outward and backward. The hand is now removed from the cheek and draws the skin of the forehead upward and tense, just above the orbital arch where the

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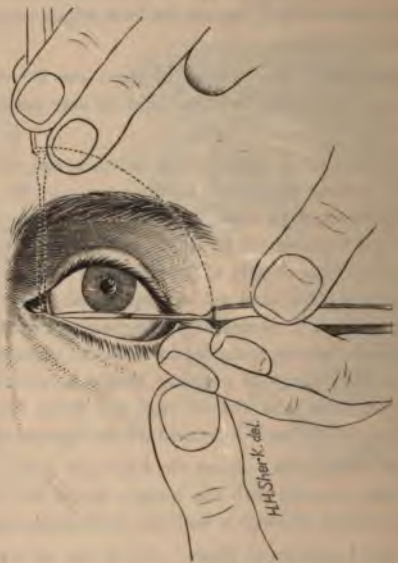
* In order to evert the lid easily, the lashes must be seized with the thumb and forefinger and the patient directed to look downward; by using another finger as stay against the lid behind, the eversion is effected with but the slightest expenditure of force. A little practice enables one to do it as well with one hand.

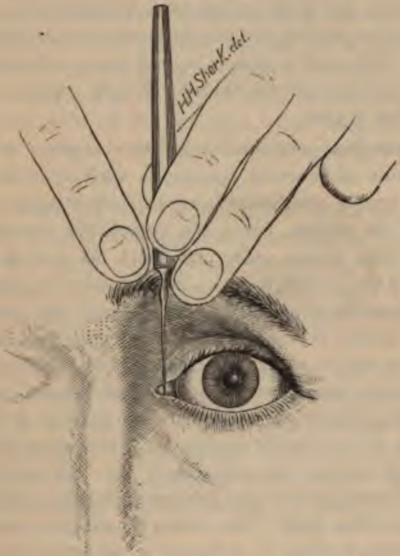
FIG. 33.



knife handle rests. With the greatest care that no false passage is being made, the knife is firmly, yet delicately, pushed well into the duct, or till it is felt the floor of the duct has been reached. (Fig. 34.) Frequent catheterization with probes is subsequently necessary, till the stricture shows no tendency to recur. If, despite these efforts, this tendency persist, a silver style may be inserted for a varying period of time.

Peritomy.—After several instillations of cocaine have been made, the lids are held open by a speculum, the surgeon standing behind the patient.

FIG. 34.



A fold of conjunctiva near the cornea is raised by the fixation forceps and divided by the scissors. For partial pannus a band of circumcorneal conjunctiva about 5 mm. wide is dissected off upon the side of the engorged vessels. If the pannus be general a complete zone must be cut away, with the subconjunctival tissues, to the sclera, in order to form a dike of cicatricial tissue against the convergent vessels. The immediate result seems, apparently, to have made matters worse, but the final outcome is usually very satisfactory.

Tenotomy.—Instillation of cocaine is the only anæsthetic agent required. The patient is recumbent, the surgeon in front, upon the right side. The speculum is adjusted, and a fold of conjunctiva lying between the insertion of the tendon and 3 mm. from the cornea is seized with the fixation forceps in the left, and divided in a horizontal direction, the opening, with the underlying capsule of Tenon, being enlarged, to admit the introduction of the instrument. The strabismus hook—handle pointing downward—is then entered below the tendon, and with its point lightly against the globe, the handle is swept outward and upward in such a manner that the whole of the tendinous attachments may be included in the angle of the hook, and these, having been brought well to the front, are divided close to the globe by the scissors thrust carefully between the hook and the globe. It is well to make a second sweep with the hook, to make sure no fibres have been left undivided. A light antiseptic bandage may be worn for a day or two.

Advancement (best performed under ether) is preceded by a tenotomy, after which a wide conjunctival opening is made upon the opposite side, the sclera and tendon attachment being exposed without breaking up the connections of the tendon, fascia and conjunctiva outward. The strabismus hook is then passed under and about the tendon, which is then to be grasped by the fixation forceps—in the hand of an assistant—at some distance back from the scleral attachment and from the hook held by the surgeon. The tendon is now severed close to the globe, and a portion of the free end or flap is cut off corresponding to the shortening desired. Three silk sutures, armed with small curved needles, are now passed through the conjunctival and tendinous flap attached to the globe, and through the flap of the divided tendon and conjunctiva in such a manner that the delicate tension now given shall draw the two flaps firmly together. The sutures are tied, and cold-water dressings used to keep down inflammation for a few days. The sutures should not be taken out for four days. The ametropia must be corrected at once upon use of the eye, by proper spectacles, which aid greatly in bringing about a proper convergence, though a considerable period of time is required to effect this.

Paracentesis of the Anterior Chamber.—The cornea having been anæsthetized by cocaine, the speculum is adjusted and the conjunctiva firmly seized by the fixation forceps near the corneal attachment and opposite the point of the proposed insertion. A bent triangular keratome is then inserted at the corneo-scleral margin, at first in a perpendicular direction, in order not to split but to pierce the cornea. When the point of the keratome has passed the substance of the cornea, the blade is turned parallel with the iris and pushed forward in front of the iris till an opening of the desired size is made. Care must be taken, in the outrush of aqueous, that the iris is not swept into the lips of the wound, and that it do not get entangled there at any time. In case this accident should happen, the iris must be replaced by a small flat spatula, and instillation of eserine made.

In **Staphyloma of the Cornea**, where there is a healthy globe and no excess of tension, the base of the staphyloma may be transfixed by several needles bearing strong silk sutures, the punctures and counter-punctures being in the healthy sclerotic. The staphyloma is then divided in two halves horizontally, the lines of division extending into the healthy tissue. These two portions are then dissected off, and the edges of the normal sclera brought together by tension upon the sutures, which are tied till union takes place. In this way a stump may be made for tattooing or for an artificial eye. If cyclitis follow the operation, enucleation is to be done at once, provided there be a useful eye in which sympathetic ophthalmitis may be excited.

In **Conical Cornea** the older method of von Graefe was to produce an artificial ulcer by wounding the apex and preventing the healing by subsequent applications of silver nitrate, till an inflammation of sufficient extent had been set up to produce sufficient contractile effect of the cicatricial tissue to reduce the curvature of the cornea. An artificial pupil was then required under the clear portion of the cornea.

Trephining and the removal of an oval piece of the cornea have been tried. In the latter method more central vision is obtainable, if successful, by excision of a piece beneath the centre, and allowing a small flap of clear cornea to fall over the space, followed by moderate pressure bandage till union has taken place. All operations are, however, subject to a doubtful prognosis and advisable only as a *pis-aller*. Irregular astigmatism is a certain result.

Tattooing the Cornea is done with a thick solution of India ink, which is spread over the leucoma, and the surface beneath punctured with a multiple tattooing-needle.

Iridectomy.—Cocaine is the only anæsthetic required, though we have found that in cases of extreme glaucomatous tension it has but little effect. The instruments required are a speculum, a large bent keratome, iris forceps, and scissors, or a de Wecker scissors. The incision is sometimes preferably made with the v. Graefe cataract knife. It should be from above, as the coloboma here is less disfiguring and troublesome than when made below, though for an artificial pupil it may have to be made at any point where the clear space permits. The keratome is entered as in paracentesis, but the line of incision must be longer, to give sufficient room for drawing forth the iris. The iris forceps are inserted closed, and delicately advanced to the pupillary margin, when they are allowed to open and inclose a portion of the iris corresponding to the width of the coloboma desired—wide in glaucoma, narrow if only for an artificial pupil. This portion of iris is now carefully drawn out of the lips of the corneal wound, and, with a slight movement forward, is slowly cut, close to its basilar attachment, by the scissors, whose lower blade has been inserted beneath and within the edges of the incision of the cornea. In making this cut with the scissors the lower blade must be held parallel with the base of the iris, closely up to it, and must not move while the upper blade is made to descend upon it and the enclosed loop of the iris. Great care and scrutiny must now be given that no parts of the iris are caught in the wound—a small spatula being used to clear the opening and replace the iris.

When the lens is absent, the blades of the scissors may be inserted through a keratome incision and a mere radial snip made, or a $\wedge$-shaped piece cut from the iris. This is called **Iridotomy.** The eye is to be lightly bandaged for a few days, during which complete rest is advised.

Sclerotomy.—A v. Graefe cataract knife is used, the iris having been previously contracted by eserine, and the puncture is from one to two millimetres from the cornea in the sclerotic, and about two mm. below a horizontal line across the upper corneo-scleral junction. The knife is steadily advanced through the anterior chamber, parallel with the iris, and counter-puncture effected opposite the entrance, as is shown in Fig. 35. The knife is now drawn back and forth and upward till only a small bridge of sclerotic tissue remains undivided, which is left intact. The knife is now slightly rotated on its longitudinal axis so that the lips of the wound are held apart while the aqueous escapes slowly and to the desired degree. A sudden gush of aqueous should on no account be allowed, and especially in case of high tension, since this may produce dislocation of the lens or retinal hemorrhage. The iris must not be allowed to be caught in the wound. The knife must be withdrawn with extreme care, so as not to cut the edges of the wound in any manner.

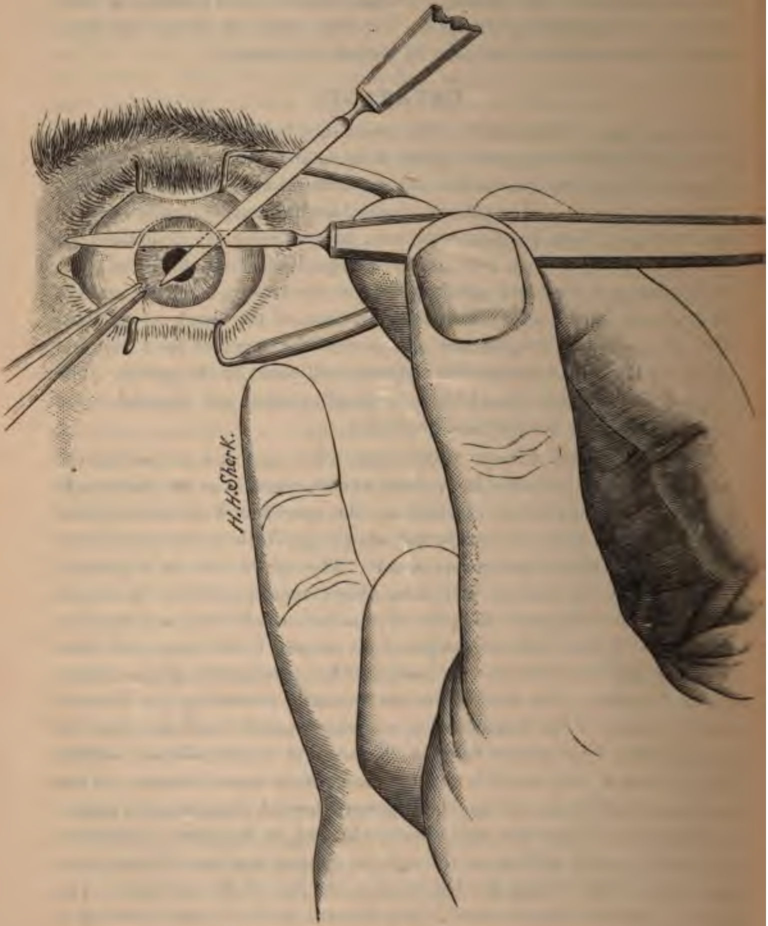
Discission.—The pupil is to be dilated and the eye anæsthetized by cocaine. The discission stop-needle of Bowman is the safest; it is entered perpendicularly at a point midway between the centre of the pupil and the corneo-scleral margin in the lower and outer quadrant. The capsule of the lens is entered by the needle point, and a vertical sweep of the handle of the knife, using the cornea as a fulcrum, divides the capsule up and down, while transverse strokes may be made if an extensive rupture is desired. The needle should be brought rapidly out of the incision after having brought the handle to a perpendicular, and the edges of the needle faced the same as in entering. Atropia must be used continually while the lens is undergoing absorption. If iritis break out during this time, immediate extraction of the lens by suction is necessary.

CATARACT.

Preliminary Treatment.—We cannot but believe that the unexceptional success following every operation for cataract we have had has been, at least in part, due to a careful and strict attention to this matter of preliminary treatment. The patient's general health must be closely inquired into, freedom from coughs, colds, etc., being among the conditions for operation. For a week previous to the operation, Formula 36 is given *t. d.*, insuring a free and open condition of the bowels, an active state of the excretory functions, and a healthy condition of the blood. Inunctions of F. 26. upon the temples may also precede the operation for a day, and especially if the first formula has not been well borne by the system. The eye and instruments should be antiseptically treated just previous to the operation, the eye anæsthetized by cocaine.

The Peripheral Linear Extraction.—The patient is recumbent, the surgeon in front or behind the patient, as circumstances or his preferences dictate. The instruments required are the speculum, fixation forceps, v. Graefe cataract knife, iris forceps and scissors (or Wecker's scissors), a bent cystotome, a rubber spatula and spoon. The eye is held by a grasp of conjunctiva in the fixation forceps, made as close as possible to the margin of the cornea and opposite the point of puncture, which last is to be between one and two mm. from the margin of the cornea, in the upper and outer quadrant, and two mm. below the horizontal line, passing through the corneo-scleral junction. The blade is, in the normally protruding eye, directed toward the tip of the patient's nose, and enters parallel with the iris. In this direction it is pushed forward till the point of the knife has reached the centre or a point but little past the centre of the anterior chamber, when the hand is dropped and the blade pointed toward the place of counter-puncture directly opposite, and similarly located, to the point of puncture. The blade is now pushed on through the counter-puncture till the end of the cutting edge toward the handle is at the lips of the puncture. The edge of the knife is now turned a little forward, so that it shall come out at the junction of the sclera and cornea, and the handle elevated a little, so as to start the cut without any sawing motion, such as is usually advised, but which we wholly disapprove of. If, now, too much tension be not given

FIG. 35.



the muscles of the hand, an easy and middling rapid sweep, combined with a slight elevation and circular movement in withdrawing the hand, will carry the blade through the tissues and out at the desired point. In this way the jagged edges of the wound, almost inevitably connected with any sawing movement, are obviated; there is less escape of aqueous, less gaping of the wound for entrance of septic material, and, lastly, the edges of the wound are more regularly apposite for perfection of subsequent healing. If the novice find that he is about to make a sclerotomy in this way, he must not stop and "saw," but carry out the sweep, as the bridge of unsevered tissue can be better separated by the iris scissors afterward than by the knife at the time. The iridectomy forceps are now entered, closed, and advanced till their points are opposite the pupillary edge of the iris, when the forceps are allowed to open and enclose a portion of the iris, no larger than is required to secure a firm hold upon a fold grasped at the pupillary margin. This is drawn out of the lips of the wound and slightly advanced till it is rendered taut; the lower blade of the iris scissors is now gently slipped into the lips of the wound, below the iris fold, and held horizontally and firmly in place, while the upper blade is made to descend and sever the iris fold close to its ciliary attachment.

The cystotome, having been bent to suit the conformation of the parts, is now inserted and the capsule thoroughly ruptured by several incisions upon each side of a quadrilateral whose corners reach the extreme point of the iris retraction producible by atropia. A rubber spatula or spoon is now pressed against the lower edge of the cornea in such a manner as to tilt the upper edge of the lens forward, and a gentle upward teasing force is exerted, slowly and patiently, till the edge of the lens appears. At this point pressure must be slightly lessened, to avoid any loss of vitreous, and the lens coaxed out with delicate manipulation and the least force possible. We must now clear the edges of the wound, make a sharp scrutiny for cortical and capsular shreds and remains, either in the wound or in the anterior chamber. Blood in the anterior chamber is not, as a rule, productive of bad results, being generally absorbed within 24 hours. It is, however, well to clear out what hemorrhage we can by gentle stroking and pressure from below upward upon the cornea. The greatest care is now required to replace the iris and see that none of its filaments are caught in the wound. Instillations of atropia are made and the dressings applied. These consist of oval pieces of patent lint, 1½ inches in long diameter, lightly covered with simple vaseline and laid on both lids. Over these a large piece of the dry lint is laid, extending on to the forehead and cheeks, with a central vertical slit in it, to leave the nose f

The hollows of the eyes are filled, to a level with the nose, with loose absorbent cotton, and a black knit bandage, with two tapes at each end (those at one end much longer than the others), is lightly tied over the whole. The patient may be kept in a dark room,* and not be allowed to rise or exert himself in any way for 24 hours. To insure rest, one grain of powdered opium may be given upon the evening following the operation. The preliminary treatment should be continued during convalescence till a very faint mercurial odor is detected in the breath. Atropine may be suspended the third day, if no iritis has followed the operation. In 24 hours after the operation the patient may sit up for a time, the room being moderately lighted. The bandage must not be permanently removed for from 7 to 10 days, and the eyes accustomed to the light only gradually. The first dressing after the operation is to be made in 24 hours; the old dressings having been carefully removed, the lids and surrounding parts are gently sponged and washed with warm water and F. 1. New dressings, just like the first, are prepared, atropine dropped into the eye, and both eyes bandaged as before. This should be repeated till the bandage is left off entirely, its place being supplied by colored spectacles. In about 20 days the patient may be fitted with proper spectacles.

Contingencies and Accidents.—If the vitreous should break forth before the delivery of the lens, the latter will not be delivered by pressure. A Critchett scoop must at once be deftly inserted behind the lens, which is drawn out by its aid. If there be a small escape of vitreous after the lens, it should be seized by the iris forceps and cut off with the scissors. No serious result follows the loss of a small portion of vitreous. It may happen that the lens is unusually large, or the wound have been made too small, so that the moderate pressure which is alone admissible will only bring the lens to the edge of the wound. In such a case the wound must be enlarged by a slight cut with the scissors, made in continuance of its general direction.

Should the eye, instead of healing, be found to suppurate, mercurial inunctions of the temples are to be freely and thoroughly made, 4 to 8 leeches applied, and hot fomentations frequently given the eye and surrounding parts. If these measures do not arrest the suppurative process, the only hopeful treatment is of a heroic nature. The wound should be completely opened, the anterior chamber thoroughly syringed and washed with F. 1, and the conjunctival folds treated in the same way. This is to be repeated several times, or till the suppuration cease. If the process continue persistently, the galvano-cautery of the whole of the corneal wound is the only remaining hope of saving the eye from panophthalmitis. If iritis supervene during the otherwise normal recovery of the eye, it must be treated as an ordinary attack.

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* Dr. Michel, of St. Louis, and Dr. Chisolm, of Baltimore, have dispensed with all bandages, compresses and dark rooms in the after-treatment of cataract and iridectomy operations, and express themselves highly pleased with the results. A strip of isinglass plaster is placed over the lids, the patient, from the first, being kept in an ordinarily lighted room. (See *Am. Journ. Med. Sci.*, Jan., 1887). This, the so-called, "rational treatment," certainly deserves careful consideration at the hands of the profession.

The Linear Extraction, which v. Graefe modified into the now most generally accepted "Modified Linear," is suitable only for soft cataracts, for those below the age of 30. It was a small keratome incision within the corneal margin, through which the lens pulp was squeezed. It has been supplanted by the more commendable

Suction Operation.—An incision is made through the cornea with a broad-pointed needle, at about the same location as in discission. The lens capsule is freely lacerated with the broad needle, and the nozzle of a Teale or Bowman syringe passed through the opening and slightly dipped into the lens matter. The suction should be gentle and slow, care being taken not to rupture the posterior capsule or injure the iris.

Modifications, etc.—The Flap Extraction was the usual one until v. Graefe introduced the Modified Linear. **The Flap Extraction** was made by a Beer knife, either above or below, generally the latter, the puncture being in this case at the corneal margin and slightly below the centre. The counter-puncture was directly opposite. This large flap of cornea which, even not severed, is nourished with great difficulty, led to such frequent suppuration that von Graefe was led to devise the operation above described. Various modifications in the details have not led to any widely-accepted deviation from the principal, which was that of a straight or linear wound instead of a flap, and its location in the sclerotic, with an iridectomy. **Critchett** made the puncture and counter-puncture 1 mm. from the corneal edge and 3 mm. below its upper tangent, the knife emerging still in the sclerotic but yet close to the corneo-scleral junction. **De Wecker's** cut was at the junction and 3 mm. deep. Others have proposed or practiced a corneal section in the v. Graefe manner, either upward or downward, with and without an iridectomy. The advantage of not performing an iridectomy is the resultant normality of the pupil and iris; the disadvantage is, that the iris is often so wounded by the passage of the lens that iritis follows, or that the iris becomes incarcerated in the wound and leads to irido-cyclitis, etc. **Pagenstecher** extracts the lens in its capsule, thus obviating the possibility of the extremely troublesome sequel of recurrent capsular cataract. He accomplishes this by means of a large incision in the sclerotic, 1 mm. from the cornea, and after an iridectomy a scoop is introduced behind the lens, drawing out the lens and capsule *en masse*. **Macnamara** extracts the lens in its capsule, without an iridectomy, through a corneal keratome incision and by the use of a scoop. Though this is the ideal of all operations—*i.e.*, the *safe* extraction of lens and capsule without iridectomy—no other surgeons have adopted Macnamara's method, either from the extreme delicacy it requires or from the even extremer danger attending it.

Recurrent Capsular Cataract.—No operation should be undertaken until long after all signs of irritation from the previous one have disappeared. An incision is made with a keratome at the corneal margin, and a delicate hook is inserted, with which the capsule shreds are extracted. The aid of long, fragile iris forceps may be required. If it is desired only to displace shreds or break away a clear space, a discission needle may effect this, entered as in the discission operation. A second needle, entering from the opposite side, is found very effectual for this purpose. Sometimes with the hook the capsule easily gives way at its peripheral attachment, and with deft manipulation may all be brought away in a mass, without any injury to the ciliary body or iris. But the extremest care and lightness of touch are necessary.

Enucleation of the Eyeball.—The patient is under the influence of ether, the eyelids held widely apart by the speculum, and a fold of conjunctiva is seized by strong fixation forceps in the left hand, and opened by a snip of the strabismus scissors. The conjunctiva is then cut close to the cornea and completely around the same, after which the tendon (if of the right eye, the internal rectus; if of the left, the external) is seized by the fixation forceps and close to its insertion. A stroke of the scissors severs the tendon to the right of the forceps, which continue their hold and steady the globe, while the other tendons of the eye are divided close to the globe. The superior oblique and superior rectus are severed at one clip, next the two inferior muscles, likewise at one stroke; the globe is then rotated toward the nose, so as to bow the optic nerve outward, and for severing this last a strong grip of the hand upon the scissors is required. (It will be remembered that this division should be made as far back toward the orbital apex as possible in cases of glioma of the retina.) The forceps are now dropped, the globe itself seized with the fingers, and, having forced the same out of the socket, the remaining tendon is quickly cut, likewise close to the ball. Cold, wet, antisepticized sponges are crowded into the orbit to stop the hemorrhage, and a tight compress binds these, with a layer of absorbent cotton, firmly in place. In a few hours the bandage and sponges may be removed, the orbit cleansed and dressed more loosely. This manner of enucleation insures the best socket and movement of

The Artificial Eye.—Those of Müller are highly recommended, and may be fitted in about a month, if all inflammation has subsided. The eye should not be worn over an hour or two a day, at first. To insert an artificial eye, it must be wetted, and the broad, outer end pushed vertically under the upper lid, which is slightly raised by the operator's left hand. The lower lid is then drawn downward, the patient directed to look down, and the eye is delicately slipped and rotated into place.

WOUNDS AND INJURIES OF THE EYE.

Ecchymosis—"Black Eye."—This is a superficial extravasation of blood into the tissues of the lids or surrounding parts. If the globe has not been injured, nor the orbital walls fractured, cold bathing, or iced compresses, may be employed for the first day or two, or F. 6 may be instead or thereafter applied as a lotion. The absorption of the extravasated blood will take place in about ten days.

Foreign Bodies in the Conjunctival Sulcus.—Undoubtedly many a case of this kind is mistakenly diagnosed as conjunctivitis, especially in children. If the irritation be monocular, the palpebral folds should be examined, by eversion of the lids. If any œdema of the lids exists, it must be remembered that a view of the limits of the upper sulcus is attained with great difficulty.

Lacerating and Perforating Wounds of the Lids, if extensive, require, after thorough antiseptic cleansing (F. 1), sutures and dressing, as in an ordinary wound. If the conjunctiva of the lids have been broken through, the palpebral fold must be syringed and cleansed. Bandages and rest are advisable. We can never be sure, at first, that the globe itself, though showing no evidences, has not undergone an injury which may develop in visible signs in a few days. The greatest uncertainty may exist in regard to the existence of **a foreign body in the tissues of the orbit,** and thorough examination, and consideration of attendant circumstances, is enjoined, with this idea in mind. Remarkable instances have occurred in which such foreign substances have been overlooked. One case is proverbial, where a hat peg, three and three-tenths inches in length, was in the orbit from ten to twenty days, without its presence having been suspected. One of the authors once found a piece of a pipe stem, one inch in length, that had been buried in the orbit for several months.

Fracture of the Orbital Walls or Arches may be followed by emphysema of the cellular structures of the orbit. Cold compresses may be followed by firm, dry, absorbent cotton bandages. Straining and blowing the nose should be stopped for several days. Paralytic symptoms, such as ptosis, are to be disregarded. Cellulitis or abscess may supervene, and must be treated according to general surgical principles.

Foreign Bodies on the Cornea are best seen by oblique focal illumination. For their removal, the surgeon stands behind the patient, steadying the head against his body; the eyelids are held by one hand, and the body delicately displaced and removed by the aid of a corneal spud. If the body be too deeply lodged for this, care must be taken not to push it on through into the anterior chamber. A discission needle, entered as in discission, may push the body forward, or hold it, while being grasped by the iris forceps. If the patient be young or nervous, ether should be given, as a motion might do irreparable injury at the critical stage of the operation.

Rupture of the Sclerotic is a baneful result sometimes consequent upon a blow upon the globe. There will be hemorrhage into the intra-ocular tissues or humors, with possible loss of the latter, and of visual power, according to the hemorrhage and the damage to the coats. The tremulous iris will show dislocation if it exist. Atropia should be instilled, the eye cleansed and washed with F. 1, ice dressings applied, to be followed by a lightly-pressing bandage over absorbent cotton. If the rupture be over the ciliary body, cyclitis may be looked for and sympathetic ophthalmitis expected.*

Internal Disorders may be the result of a blow, etc., without in any way injuring the external parts of the eye. Dislocation of the lens, retinal hemorrhages or detachments, or hemorrhages into the vitreous, rupture of the iris, choroidal rupture with ensuing choroiditis, and glaucomatous symptoms, should each be looked for. If there are signs of inflammation within or without, leeches or hot fomentations should be used, atropine instilled, and complete rest, with light bandages, urged.

Penetrating Wounds require the greatest care and circumspection to determine whether fragments may be within the globe. The nature of the

* While one of the authors was at Moorfields a remarkable case came under his care where both sclerotica were ruptured by the kick of a horse; both lenses were dislocated and extracted from their lodgment in Tenon's capsule, above the sclerotic.

accident, kind of instrument, etc., must be carefully inquired into, the inside of the eye thoroughly examined by the indirect method as well as by the direct, especially using high + Sph. lenses, and searching the floor of the vitreous carefully. Pieces of glass can easily be overlooked, either on the inside or if lodged in the wound.

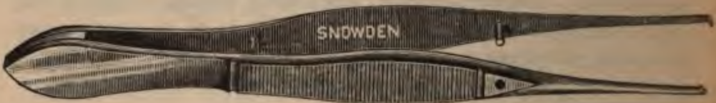
It is also important to consider the location of the perforation. If it be in the ciliary region or through the body, the serious consequences so often alluded to must be expected and combated in advance by atropine, cold, and absolute rest. Whether to enucleate or not can be decided by no rules, except in extreme cases. If a foreign body of any considerable size be in the eye, and its extraction hopeless, and the ciliary muscle pierced, there can be no prudence in postponing an immediate excision of the eye. But most all cases are open to doubt of some kind, though the doubt will, perhaps, result in frequent blindness of both eyes. A gaping wound of the sclerotic should be united with a few delicate sutures through the episcleral tissue. Traumatic cataract (with possible increase of tension) will result from any wound of the lens. We should be on the alert to guard against the entanglement of the iris in a perforating wound. Penetrating wounds from shot are often hard or impossible to discover, the shot themselves fully as hard to find.

Foreign Body in the Vitreous.—If its position be determined, and its removal even remotely possible, the attempt should be made at once. If the fragment be of a doubtful character, the electro-magnet may be used to determine whether it be metallic or not. If the needle cause it to quiver when brought in its vicinity outside the sclerotic, it is demonstrated to be possibly removable by the electro magnet. The needle may be introduced through the original wound, or a new incision made through the sclerotic close to the location of the fragment. The patient's position of head must be carefully considered if the foreign body changes with the motions of the same, so that the operation may have to be done with the patient in a sitting position. If the lens hold the body, it should be removed at once, as in cataract operation. If the fragment be directly behind the lens, its removal may be effected at the same time or immediately after the lens, which last should not stand in the way if, by its removal, that of the foreign body is alone to be expected. A foreign body in the vitreous rarely fails to set up hyalitis, glaucoma, retinal detachment and even sympathetic ophthalmitis.

Burns, Scalds, etc.—The chief care, in such cases, is to prevent symblepharon and ankyloblepharon, these adhesions, if forming, being frequently broken down by movement. If the cornea has been denuded of its conjunctiva and epithelium, the progress of corneal ulcer must be checked, as in idiopathic cases. Castor or olive oil and atropine should be dropped in the eye twice a day in all these injuries, and cold, even ice, freely used upon it. Some of the worst injuries are caused by lime or other caustics or acids. In such cases, if seen so early that any of the corrosive substance may be supposed lodged in the folds, these should be thoroughly syringed and washed with weak solutions of the antidote most speedily obtainable—vinegar, for example, if the injury were by an alkali; magnesia, if by an acid. Cold applications are in these injuries especially indicated, though if iritis supervene, cold is occasionally irritating instead of beneficial.

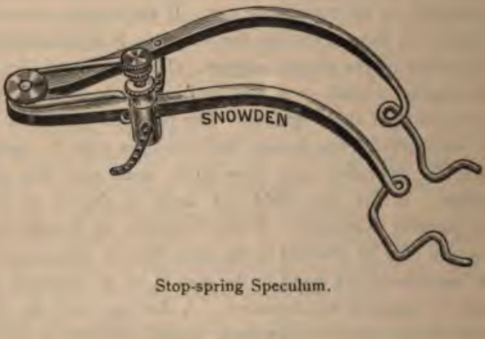
SURGICAL INSTRUMENTS.

FIG. 36.



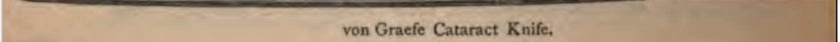
Fixation Forceps.

FIG. 37.



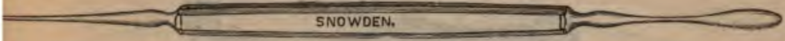
Stop-spring Speculum.

FIG. 38.



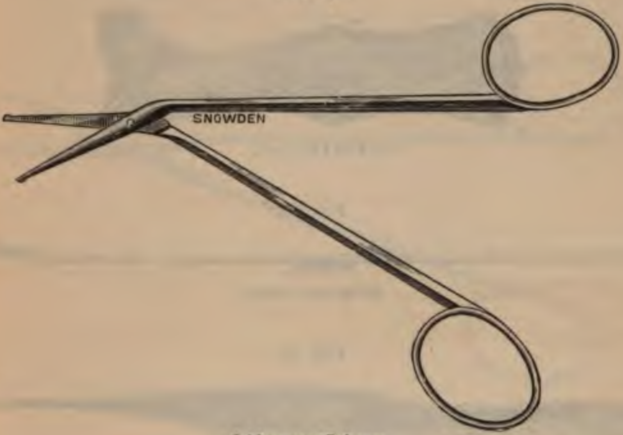
von Graefe Cataract Knife.

FIG. 39.



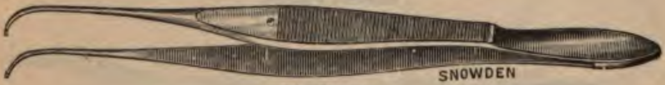
Cystotome and Daviells Spoon.

FIG. 40.



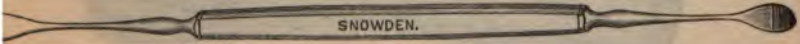
Iridectomy Scissors.

FIG. 41.



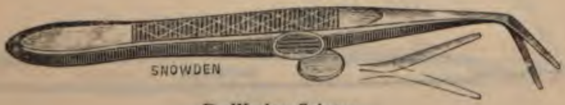
Iris Forceps.

FIG. 42.



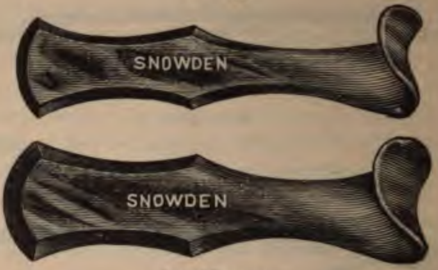
Critchett's Cataract Spoon.

FIG. 43.



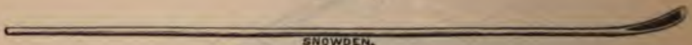
De Wecker Scissors.

FIG. 44.



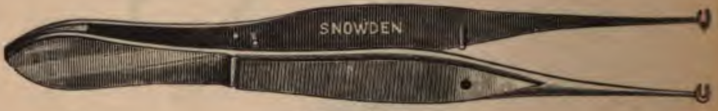
Lid Elevators.

FIG. 45.



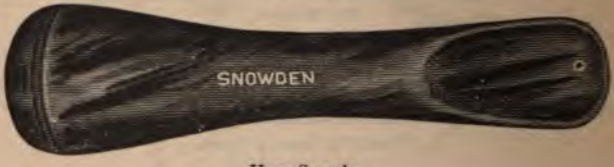
Meibomian Scoop.

FIG. 46.



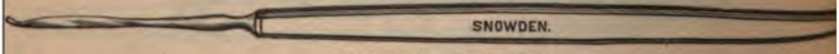
Ligature Forceps.

FIG. 47.



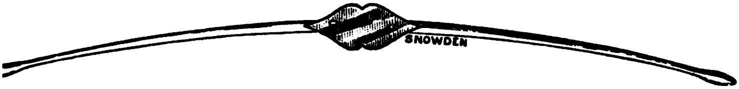
Horn Spatula.

FIG. 48.



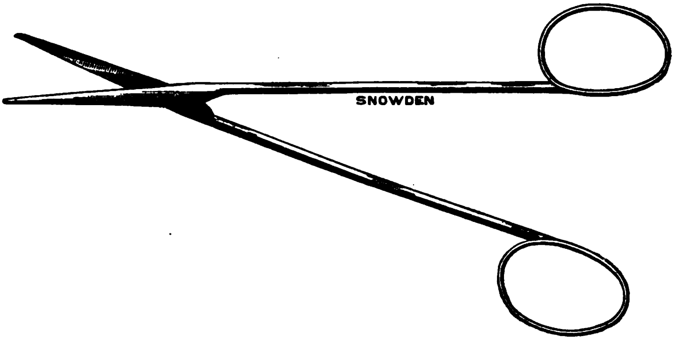
Weber's Canaliculus Knife.

FIG. 49.



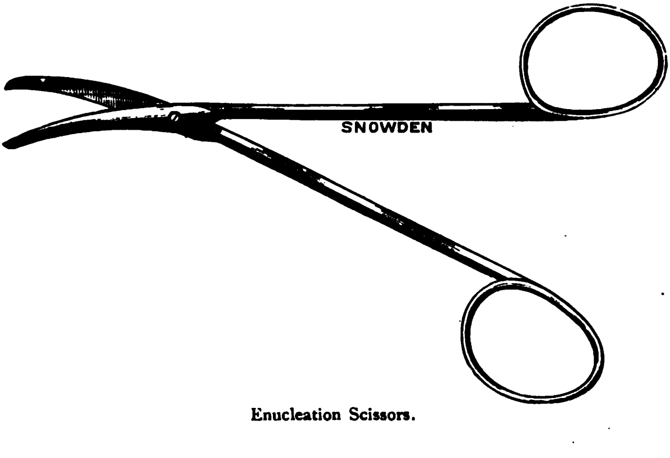
Lachrymal Probe (3 probes, 6 sizes).

FIG. 50.



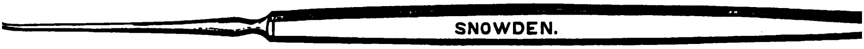
Strabismus Scissors.

FIG. 51.



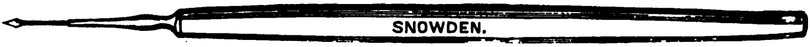
Enucleation Scissors.

FIG. 52.



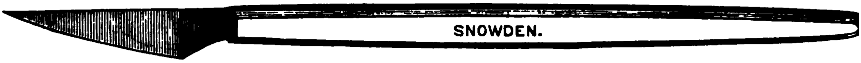
Strabismus Hook.

FIG. 53.



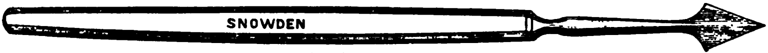
Stop Discission Needle.

FIG. 54.



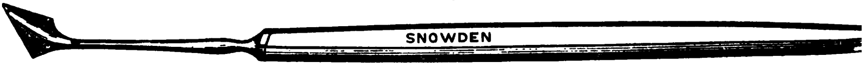
Sichel's Cataract Knife.

FIG. 55.



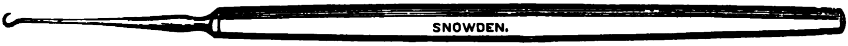
Straight Keratome.

FIG. 56.



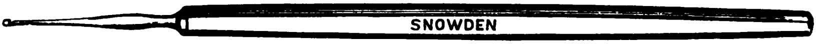
Bent Keratome.

FIG. 57.



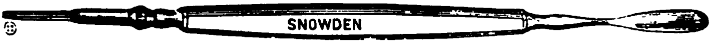
Tyrell's Hook.

FIG. 58.



Streatfeild's Ivory Hook.

FIG. 59.



Tattooing Needle.

FIG. 60.

Silver Style.

STATISTICAL.

According to the latest returns, there are in Europe and the United States the following numbers of blind people:—

	Number.	*Per 100,000 Inhabitants.*
England	24,720	95
Scotland	3,240	91
Ireland	5,936	111
United Kingdom	33,896	97
France	28,491	74
Germany	26,170	58
Austria	32,336	85
Switzerland	2,640	95
Italy	28,100	99
Spain	35,290	216
Belgium	4,182	76
Holland	2,410	61
Sweden	4,120	91
Norway	3,730	208
Denmark	2,450	126
Europe	203,815	91
United States	20,430	40
Total	224,245	81

In 41 Clinical Reports of European and American Ophthalmological Institutions, the following were the numbers of the different orders of the affections treated (1884, or years immediately preceding):—

Eyelids	16,952
Conjunctiva	44,958
Cornea	38,754
Sclera	864
Iris	11,061
Choroid and ciliary body	
Glaucoma	1,495
Optic nerve	2,986
Retina	2,491
Lens	10,302
Vitreous	1,162
Globe	2,437
Refraction	26,483
Accommodation	
Muscles	6,006
Fifth and facial nerves	
Lachrymal apparatus	5,220
Orbit	325
Amblyopia	1,306
Amaurosis	599
Achromatopsia	58
Hemeralopia	88
Traumata	3,410
Total	176,957

Magnus finds 478 cases, out of 2275 (21 per cent.), of ocular disease, in his clinic, to have been induced by general morbid conditions, as follows:—

Scrofula	16.79 per cent.	Pregnancy and puerperal fever	0.21 per cent.
Measles	1.32 "	Diphtheria	0.13 "
Syphilis	0.61 "	Hysteria	0.13 "
Cerebral	0.52 "	Scarlet fever	0.08 "
Tabes	0.39 "	Typhoid fever	0.04 "
Albuminuria	0.21 "	Erysipelas	0.04 "
Anæmia	0.21 "	Basedow's disease	0.04 "
Tuberculosis	0.21 "		

In 54 clinical reports of European and American Ophthalmological Institutions the following surgical operations were performed in 1884 or years immediately preceding —

Total operations on the lens	7,504
Total extraction of the lens	5,762
Peripheral linear extraction (v. Graefe)	4,598
Simple linear extraction	286
Extraction by Wenzel's method	24
Peripheral flap	25
Scleral extraction	59
Extraction in the capsule	120
Flap extractions	3
Extraction of traumatic cataracts	165
Discission	463
Discission of secondary cataract	741
Capsulotomy	54
Total of iris operations	6,683
Total iridectomies	5,935
Iridectomy for glaucoma	853
Iridotomies	146
Operations upon the cornea	1,666
" " conjunctiva	681
" " eyelids	4,606
" " muscles	3,627
" " lachrymal apparatus	2,535
Enucleations	1,323
Operations upon the orbit	103
Neurectomies	42
Sclerotomies	200
Extraction of foreign bodies from the globe	40
Puncture of the retina	66
Extraction of cysticercus	14
Stretching of the optic nerve	..
Total of major operations	48,324

The results of cataract operations, not complicated with other disease, by the following surgeons, in 1884, or years immediately preceding, are shown in the following table:—

Surgeon.	*Institution.*	*Extractions.*	*Successful.**	*Medium. Degree.*§	*Failure.*¶	*% Failure.*
Pflüger	Bern	18	18	0	0	0.0
Schulek	Budapest	173	138	32	3	1.73
Rählmann	Dorpat	27	20	6	1	3.7
Sattler	Erlangen	37	37	0	0	0.0
Hippel	Giessen	29	25	3	1	3.4
Rydel	Krakau	64	56	3	5	7.8
Just	Zittau	82	75	4	3	3.6
Maier	Karlsruhe	42	39	2	1	2.24
Schöler	Berlin	55	45	5	0	0.0
Schröter	Leipzig	27	26	1	0	0.0
Siklóssy	Budapest	144	135	7	2	1.38
Tacke	Brüssel	45	40	4	1	2.25
Dor	Lyon	32	31	1	..	...
Fieuzal	Paris	368	336	25	7	2.0
Jany	Breslau	94	78	8	1	1.6
Dietz	Nürnberg	17	14	..	3	17.6
Pagenstecher	Wiesbaden	71	64	6	1	1.4
Wicherkiewicz	Posen	44	43	1	0	0.0
Steffan	Frankfurt	24	23	..	1	4.1
Schreiber	Magdeburg	8	8	0	0	0.0
Dürr	Hanover	25	20	5	0	0.0
Knapp	New York	36	31	4	1	2.7
Derby	Boston	95	70	11	14	14.7
Bäuerlein, '69 to '83	Würzburg	400	340	42	18	4.5
Rydel, '83	Krakau	45	42	1	2	4.4
Schöler, '83	Berlin	52	48	3	1	1.8
Schröter, '83	Leipzig	36	35	0	1	2.8
Fieuzal, '83	Paris	273	239	15	19	6.9
Pflüger, '83	Bern	29	28	1	0	0.0
Knapp, '83	New York	62	56	5	1	1.6
Schöler, '82	Berlin	41	37	2	2	4.8

* = V. = $\frac{20}{20}$ to $\frac{10}{100}$. § From $\frac{10}{100}$ to $\frac{20}{200}$. ¶ From ∞ to nil.

Myopia is rarely found in young children, who are almost always hyperopic. The increase of school years or other prolonged near work brings with it an invariable increase of refraction. City and town school children are more myopic than country children. Erismann examined 350 eyes which he had, six years previously, accurately tested, and found—

Refraction unchanged	23 %
" increased	67 "
Hyperopia diminished	7 "
" changed to emmetropia	8 "
" " myopia	13 "
Emmetropia " "	16 "
Myopia increased	25 "

Derby found that in 3 years 10.6 % of the emmetropes of Harvard College became myopic; 21.2 per cent. of the myopes became more so, while 16.6 remained stationary.

Among males of the same age, Tscherning finds myopia distributed as follows:—

	Total.	*Myopes.*	*%.*
Day laborers, peasants and sailors	2326	57	2.45
Mechanics of various kinds	2861	150	5.24
" engaged in near work	566	66	11.66
Artists, engineers and architects	270	36	13.33
Merchants	1009	159	15.76
Professional men	491	159	32.38

Myopes are estimated to be from 30 to 55 % of the scholars of the German *Gymnasia*, from 20 to 40 % of those of the industrial schools (*Realschulen*).

FORMULÆ.

1.	Acidi borici		gr. xij
	Aquæ camphoræ,		
	Aquæ destillatæ	āā	℥ ij
	Aquæ menthæ piperitæ		ʒ iss.

This is the simplest form of a much-used "L. B." collyrium, of service in all corneal and conjunctival inflammations, and as an antiseptic wash in surgical operations. It serves well as a vehicle for other therapeutic agents. A more elegant preparation is the following:—

2.	Acidi borici		gr. xij
	Mucilaginis sassafratis medullæ		ʒ ij
	Tincturæ alkannæ radicis		♏v
	Aquæ rosæ		℥ j
	Aquæ camphoræ,		
	Aquæ destillatæ	āā	℥ iss. M.

SIG.—Bathe eyes freely, as directed.

3.	Foliæ rosæ		gr. x
	Aquæ destillatæ bul.		℥ j. M.

Infuse 20 minutes in covered vessel.

A pleasant slightly astringent lotion.

4.	Acidi borici		gr. xij
	Aquæ camphoræ,		
	Aquæ destillatæ	āā	℥ ij
	Zinci chloridi		gr. iv
	Sacchari caramel		♏v
	Aquæ menthæ piperitæ		ʒ iss. M.

This mixture is useful in all muco-purulent discharges. May be used frequently.

5. To formula number 1 or 2 add—

	Tincturæ belladonnæ		
	Tincturæ opii	āā	ʒ iss.

When conjunctivitis or keratitis is associated with pain—

6.	Liquoris plumbi subacetatis		ʒ ij
	Tincturæ opii,		
	Tincturæ belladonnæ	āā	ʒ iss
	Tincturæ arnicæ		℥ j
	Aquæ camphoræ,		
	Aquæ destillatæ	āā . . q.s. . ad	℥ iv. M.

For œdema of the lids or face from bruises, dacryocystitis, etc.—

7.	Acidi borici		gr. xij	
	Aquæ menthæ piperitæ		ʒj	
	Vini opii		ʒij	
	Hydrarygyri bichloridi		gr. $\frac{1}{30}$	
	Aquæ camphoræ,			
	Aquæ destillatæ	āā	℥ij.	M.

Beneficial in catarrhal ophthalmia and in all inflammations with purulent discharges.

8.	Acidi borici		gr. xvi	
	Hydrargyri bichloridi		gr. $\frac{1}{40}$	
	Aquæ camphoræ,			
	Aquæ destillatæ	āā	℥ij.	M.

Of frequent use as a cleansing and antiseptic wash in ophthalmia neonatorum.

9.	Acidi borici,			
	Tincturæ belladonnæ,			
	Vini opii	āā	ʒj	
	Zinci chloridi		gr. iv	
	Aquæ camphoræ,			
	Aquæ destillatæ	āā	℥ij.	M.

In ophthalmia neonatorum with marked œdema of the lids.

10.	Aluminis pulvis		gr. xx	
	Hydrargyri bichloridi		gr. $\frac{1}{30}$	
	Eserinæ sulphatis		gr. ij	
	Vini opii		ʒij	
	Aquæ camphoræ,			
	Aquæ destillatæ	āā	℥ij.	M.

As a lotion in gonorrhœal ophthalmia.

11.	Zinci chloridi		gr. iv	
	Quiniæ hydrochloratis		gr. x	
	Eserinæ sulphatis		gr. ij	
	Vini opii		ʒij	
	Aquæ camphoræ,			
	Aquæ destillatæ	āā	℥ij	M.

Useful in gonorrhœal ophthalmia with a membranous deposit.

12.	Aquæ chlorinæ (Evans)		℥iv.	

Excellent in all purulent inflammations.

13. Atropiæ sulphatis . . . . gr. iv
Aquæ destillatæ . . . . ℥j. M.

This strength is sufficient to give full mydriasis and paralysis of the accommodation. Its use t. d. is often enough to produce this effect in the most stubborn cases. Persistently used it sometimes brings on atropia irritation, and when continued mydriasis is desired, gr. j to ʒ iij is a sufficiently strong solution. If pupillary dilatation is all that is desired gr. $\frac{1}{4}$ to ℥j.

14. Atropiæ sulphatis . . . . gr. $\frac{1}{100}$
Aquæ destillatæ . . . . ℥j. M.
SIG.—One drop in each eye, each night or alternate nights.

This weak solution has for us proved very successful in quieting irritative and spasmodic activity of the ciliary muscle, especially during "the period of adaptation" immediately succeeding the first use of spectacles.

15. Homatropinæ hydrobromatis . . . . gr. iij
Aquæ destillatæ . . . . ʒ vj. M.

Several instillations during the hour preceding the refraction tests will generally procure the desired paralysis of accommodation. Its chief advantage over atropia in refraction, is that its effect usually passes off within twenty-four hours, whilst atropia requires a week or ten days. Hyoscyamia and duboisia are used comparatively infrequently as mydriatics.

16. Daturinæ sulphatis . . . . gr. iv
Aquæ destillatæ . . . . ℥j. M.

Useful instead of atropia in case of mothers nursing babes, and when atropia causes conjunctival irritation.

17. Eserinæ sulphatis . . . . gr. ij–iv
Aquæ destillatæ . . . . ℥j. M.

The best myotic. Of service in mydriasis and paralyzed accommodation, but especially useful in acute glaucoma, though not always certain to reduce the intraocular tension.

18. Pilocarpinæ hydrochloratis . . . . gr. ij
Aquæ destillatæ . . . . ℥j. M.

Serviceable in ulcers of the cornea.

19. Cocainæ hydrochloratis . . . . gr. x–xx
Aquæ destillatæ . . . . ℥j. M.

To relieve pain in iritis, cyclitis, and hyperæsthesia of the retina, and to produce local anæsthesia for surgical operations on the eye.

20.	Hydrargyri oxidi flavi	gr. ¼–j	
	Unguenti petrolei albi	ʒj.	M.

Ft. ungt.

For blepharitis.

21.	Hydrargyri oxidi flavi	gr. j	
	Unguenti petrolei albi	ʒj	
	Olei morrhuæ	gtt. xxx	
	Olei rosæ	q.s.	M.

For blepharitis.

22. Unguenti boroglyceridi.

For blepharitis.

23.	Atropiæ sulphatis	gr. ¼	
	Hydrargyri oxidi flavi	gr. ss	
	Olei morrhuæ	gtt. xxx	
	Unguenti petrolei	ʒj	
	Olei rosæ	q.s.	M.

For ulcers of the cornea, keratitis, etc.

24.	Eserinæ sulphatis	gr. j	
	Olei morrhuæ	gtt. xxx	
	Morphiæ sulphatis	gr. j	
	Unguenti petrolei albi	ʒj	
	Olei rosæ	q.s.	M.

For strumous ulcers of the cornea.

25.	Quiniæ hydrochloratis	gr. iv	
	Hydrargyri chloridi corrosivi	gr. 1/12	
	Daturinæ sulphatis	gr. ⅛	
	Olei morrhuæ	gtt. xxx	
	Unguenti petrolei albi	ʒj.	M.

For granular lids with pannus.

26. Unguenti hydrargyri.

For temporal inunctions, where speedy mercurialization is desired. (Lanoline used as the base).

27.	Aluminis exsiccati	gr. v	
	Atropiæ sulphatis	gr. ¼	
	Unguenti boroglyceridi	ʒj.	M.

For trachoma with pannus.

28.	Argenti nitratis	gr. v	
	Aquæ destillatæ	℥j.	M.

Sig.—One instillation daily.

Ophthalmia neonatorum.

29.	Argenti nitratis	gr. xx	
	Aquæ destillatæ	ʒj	M.

For alternative use in trachoma.

30. Lapis divinus.

Largely used upon the palpebral granulations and cicatrices of chronic trachoma.

31. Sulphate of copper crayons.

Serviceable in chronic trachoma, especially where there is much cicatricial tissue and hypertrophy of the conjunctiva

32. Alum crayons.

In subacute granular conjunctivitis.

33. Mitigated nitrate of silver crayons.

Used for quickening indolent and perforating ulcers of the cornea, and for granular lids.

34.	Morphiæ sulphatis	gr. ij	
	Olei terebinthinæ	gtt. xxx	
	Boroglyceridi (50 % sol.)	ʒiv.	M.
	Ft. unguentum.		

Sig.—gtt. i t.d.

Indolent ulcers of the cornea.

35.	Picis mineralis (black roofing pitch)	ʒij	
	Alcoholis	℥ij	
	Cola et adde		
	Aquæ ammonii f.f.f	♏viij	
	Glycerinæ	fʒvj	
	Aquæ destillatæ	f℥xij.	M.

Sig.—Lotion.

For eczema of the face and lids.

36.	Hydrargyri chloridi corrosivi	gr. j	
	Potassii iodidi	ʒij.	
	Syrupi sarsaparillæ et aquæ destillatæ . . . āā	℥iss.	M.

Sig.—Cochleare minimum t.d.

Used as a tonic and alternating medicament in all acute and subacute attacks of inflammation of the eyeball, where internal treatment is suggested; and as a preliminary to operations upon the iris, including cataracts, etc.

37.	Strychniæ sulphatis	gr. ss
	Phosphori resinæ, 4% (*Pile*)	gr. xv
	Acidi arseniosi,	
	Extracti aconiti . . . . āā	gr. j
	Extracti belladonnæ	gr. ij. M.

Div in pil. No. xx.

SIG.—One t.d.

For hyperæsthesia of the retina, pain or neuralgia in the eyeballs.

38. To the preceding add

Zinci valerianatis	gr. xxx
Quiniæ sulphatis	gr. xx

For hyperæsthesia of the retina found in general neurasthenia.

39. Infusion of Jequirity is prepared by macerating three parts of the pulverized seeds in 500 parts of cold water for 24 hours, and adding 500 parts of boiling water. Cool and filter.

CLINICAL HINTS AND MAXIMS.

Cultivate a habit of close and accurate observation of the eye. The successful ophthalmologist often suspects or bases diagnoses upon a perception of subtle and delicate differences in the external appearance of an eye that he would have difficulty in explaining or showing to another.

The eye is proverbially recognized as the organ most perfectly expressing the affections and character of the mind behind it; it is, doubtless, as reliable an indicator of corporeal pathological condition, were we only keen enough to read the signs.

There can be no accurate and exhaustive diagnosis of refractive errors without the use of a mydriatic.

There can be no accurate and exhaustive diagnosis of refractive errors by the ophthalmoscope alone.

You cannot prescribe spectacles by rules, few or thousands. Every case is "peculiar."

Asthenopia is a labor grievance, either a strike for fewer hours of work a day, or a demand for better tools.

The hyperopic eye is a miracle worker, doing the impossible in removing the "punctum remotum" *beyond* infinity. If it be a natural product, nature must be credited with a sorry illogicality—creating an organ whose natural stimulus—convergent rays of light—she has never produced at any time.

Myopia is produced by the belief that to read a newspaper (to be told what other people see) is of more value than to see for one's self.

Astigmatism is an invisible and elusive imp of mischief, requiring much keenness and patience to hunt him down. His hiding place is the ciliary muscle; his disguise, amblyopia. He hates atropia as his father was said to hate holy water.

If both physician and patient have intellectual amblyopia, mental astigmatism, or educational strabismus, how hard the cure of refractive errors that are merely ocular!

Let your expression of prognosis be indefinite rather than too precise, doubtful rather than too hopeful.

Cleanse the hands and nails thoroughly after touching a diseased eye.

Never use atropia in eyes of people over forty years of age.

Atropia is of immense service to us, but it can cure neither color blindness nor distichiasis, nor several other ailments. "A house is a gude thing, but nicht to ride o' the riggin' o't."

It is not "simple conjunctivitis" if, unsuspected by you, a foreign body is lodged between the palpebral and ocular conjunctival folds.

A large part of the blindness of the world is caused by ophthalmia neonatorum, which is both wholly preventable and curable, if some one were not at fault. *Ergo* —— *!*

In a case showing a "muddy" or "rusty" iris, associated with ciliary injection and a small pupil, instil atropia at once.

It is a saying that every good ophthalmic surgeon must spoil a hatfull of eyes before becoming a successful operator. This is not quite true; he must spoil, at least, a half-bushel or more—but they must all be *pigs'* eyes.

If an eye has been injured by an acid, wash the palpebral sulci at once with a weak alkaline solution; if the injury was from an alkali, as lime, use weak acid, vinegar and water, for example. Follow with a few drops of pure vegetable oil (olive, castor) or unsalted butter, and exclude air.

"*Tactus eruditus*"—the *sine qua non* of ophthalmic success.

Gratitude has been wittily defined as a lively sense of benefits to come. The author of the *mot* must have been an oculist.

INDEX.

ACCOMMODATION, 16, 18, 35, 51, 54, 56, 105.
Actinic rays, 10
Adaptation, period of, 48, 141.
Advancement, 59, 118.
Amblyopia, 60, 61, 101, 145.
Ametropia, 18, 20.
Ametropia model, 18.
Anatomy of the eye, 9.
Angles of incidence and refraction, 11.
Anisometropia, 49, 50.
Ankyloblepharon, 115.
Aphakia, 35, 91,
Arcus senilis, 81.
Argyl-Robertson pupil, 55.
Artificial eye, 127.
Asthenopia, 60, 145.
Astigmatism, 18, 38, 45, 146.
Atomic vibrations, 10, 11,
Atrophy of optic nerve, 103.
Axial shortening of eyeball, 32.
Axial lengthening of eyeball, 37.

BLEPHARITIS, 67.
Blepharophimosis, 115.
Blepharospasm, 56.
Blindness, 99, 136, 146.
Burns, scalds, etc., 129, 146.

CATARACT, 83, 87, 91, 121, 136, 137.
Chalazion, 68, 115.
Chorea, 56.
Choroiditis, 36, 37, 84, 86, 100.
Clinical hints, 145.
Color blindness, 64, 65.
Color field, 63.
Conical cornea, 81, 119.
Conjunctivitis, 71, 74, 76, 146.
Cyclitis, 72, 83.
Cysticercus, 92.

DACRYO-adenitis, 69.
Dacryo-cystitis, 70, 115.
Dark heat rays, 10.
Detachment of the retina, 99.
Dianoux's operation, 111.
Diffusion circles, 18.
Dioptre-dioptric system, 20, 21.
Diplopia, 57.
Direct method, 26.
Discission, 88, 120, 137.
Diseases of eye, comparative frequency, 135, 136.
Diseases of eye, due to general disease, 136.
Dislocation of lens, 91.
Distichiasis, 67, 110.

ECCHYMOSIS, 127.
Ectropion, 68, 110.
Embolism of retinal artery, 98.
Emmetropia, 18.
Entoptic phenomena, 61.
Entropion, 68, 110, 111.
Enucleation, 86, 100, 108, 126, 137.
Epiphora, 69, 70.
Episcleritis, 72, 81.
Ethereal vibrations, 10, 11.
Eversion of lid, 115.
Exclusion of pupil, 83.
Exophthalmic goitre, 109.

FAR point, 18.
Field of vision, 63.
Formulæ, 140.
Foreign bodies, 127, 129, 146.
Fraunhofer lines, 10.
Frequencies of ethereal vibration, 10, 11.
Fundus oculi, 93, 94.

GLAUCOMA, 36, 84, 104, 106.
Glioma, 99.
Goitre, exophthalmic, 109.
Granular lids, 33, 75.
Green's astigmatic test card, 41.

HEMERALOPIA, 61.
Hemianopia, 55.
Hemorrhagia, 98.
Hordeolum, 67.
Hyalitis, 91, 100.
Hyperæsthesia of the retina, 66.
Hyperopia, 18, 32, 46, 139, 145.
Hypopyon, 79, 80, 83.
Hysteria, 56, 60, 66.

ILLAQUÆTIO, 110.
Index of refraction, 11.
Index of ocular media; 15.
Indirect method, 26.
Injuries of eye, 127, 136.
Instruments, surgical, 131.
Iridectomy, 119, 123.
Iridotomy, 120.
Iritis, 72, 78, 82.

KERATITIS, 72, 77, 79, 80.

LAGOPHTHALMOS, 53.
Lenses, 13, 15, 21.
Lengths of ether waves, 10, 11.
Leucomata, 80, 119.
Light, and light rays, 9, 10.

Listing, reduced eye of, 15.
Locomotor ataxia, 55.

MACULÆ, 80.
Malingering, 61.
Megalopsia, 61.
Metamorphopsia, 61.
Micropsia, 61.
Muscæ volitantes, 61, 92.
Muscular incoördination, 57.
Mydriatics, 27, 46, 48, 143, 145, 146.
Myopia, 18, 35 37, 49, 86, 139, 146.
Myopic crescent, 37, 86.
Myosis, myotics, 57, 142.

NEAR point, 18, 50, 51.
Nebula, 78, 80.
Nyctalopia, 61.
Nystagmus, 56.

OCCLUSION of pupil, 83.
Opacities of vitreous, 92.
Opaque nerve fibres, 94.
Ophthalmia, 72, 73, 74.
Ophthalmia neonatorum, 74.
Ophthalmitis, 107.
Ophthalmoscope, 22, 145.
Optical principles, 9, 14.
Optometry, 21, 28.

PANNUS, 76.
Panophthalmitis, 85.
Papillitis, 100, 106.
Paracentesis, 86, 118.
Paralyses, 53.
Peritomy, 117.
Physiological cup, 94, 105.
Pigmentosa—retinitis, 61, 97.
Pinguecula, 77,
Presbyopia, 50.
Pseudo-glioma, 100.
Pterygium, 77.
Ptosis, 53, 115.
Pupil, 57, 83.
Pulsation of retinal vessels, 94, 105.

RANGE of accommodation, 17.
Rapidity of light, 11.
Refraction of light, 11, 12, 13.
" of Eye, 20.
" errors of, 20. .
Refraction by ophthalmoscope, 22.
" " test lenses, 26.
Retina, 92, 93.
Retinitis, 94.
Retinoscopy, 29, 42.

SCHEINER'S experiment, 31.
Scleritis, 81.
Sclerotic, rupture of, 128.
Sclerotomy, 126.
Scotomata, 85.
Snow blindness, 61.
Spasms, 56.
Spectacles, 46, 49, 59.
Spectrum, 13.
Staphyloma, 37, 79, 86, 119.
Statistics, 136.
Strabismus, 33, 37, 57.
Stye, 67.
Sunlight, 9, 10.
Surgical operations, 130.
Symblepharon, 115.
Sympathetic ophthalmitis, 107.
Synchisis, scintillans, 92.
Synechia, 80, 82.

TATTOOING the cornea, 80, 119.
Tenotomy, 118.
Test lenses, 20, 26, 28.
Test letters, 16.
Thomson, Prof., ametrometers, 31, 44.
Thrombosis of retinal artery, 98.
Tobacco amblyopia, 60, 62, 101.
Trachoma, 33, 75.
Traumata, 127, 136.
Trichiasis, 67, 110.
Tweedy optometer, 43.

ULCER of the cornea, 80.
Ultra-violet rays, 10.

VISION, perfect, 17.

WOUNDS of the eye, 127.

XANTHELASMA, 69.
Xerophthalmos, 77.
Xerosis, 77.

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